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UMLINDI
The Watchman

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INSTITUTE FOR SOIL, CLIMATE AND WATER

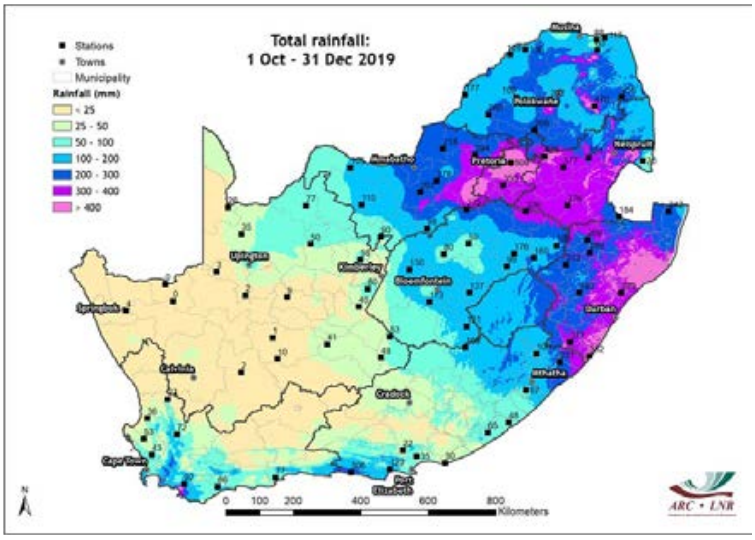
CONTENTS:

187th Edition

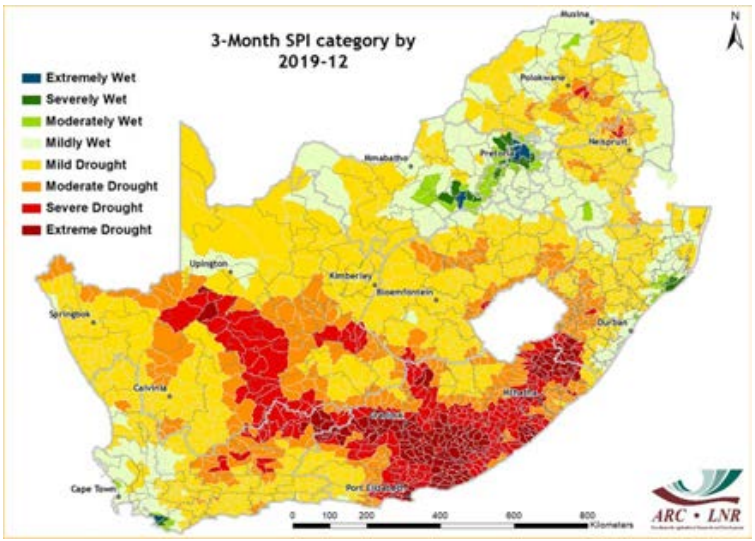
Images of the Month

Onset of the summer rainfall season: Oct-Nov-Dec

The 2019/20 summer rainfall season began with dry, scorching weather during the month of October over the central and northeastern parts of the country. Persistent rainfall with destructive winds were then observed during November, and continued into December, causing localized flooding over parts of the Limpopo, Gauteng, Free State, KwaZulu-Natal and Mpumalanga provinces. The rainfall map for this 3-month period shows that the northern Highveld and the KwaZulu-Natal coastline received in excess of 300 mm. Although significant rains were delayed at the onset of the summer season, this rainy weather brought welcome relief from the very hot temperatures, improved vegetation activity to some extent and allowed crop planting to commence.



Meanwhile, the drought situation has not improved in the Eastern Cape and adjacent areas of the Western Cape and Northern Cape. The 3-month Standardized Precipitation Index (SPI) map indicates the short-term drought conditions since the beginning of the summer rainfall season. However, agricultural activities have been subjected to prolonged drought conditions caused by low rainfall and high temperatures, leading to high evapotranspiration rates. These conditions have further resulted in reduced agricultural water for both crops and livestock, and consequently affected livelihoods in the drought-stricken areas as well as the economy of the country. Other factors considered to aggravate drought impacts include excessive land use, soil erosion, over-exploitation of available water, increasing population and societal behaviour.



The Agricultural Research Council - Institute for Soil, Climate and Water (ARC-ISCW) collected the data, generated the products and compiled the information contained in this newsletter, as part of the Coarse Resolution Imagery Database (CRID) project that was funded by the Department of Agriculture and Department of Science and Technology at its inception and is currently funded by the Department of Agriculture, Land Reform and Rural Development.

1. Rainfall

Overview:

A notable increase in total rainfall was observed in December 2019, with the summer rainfall season well underway. The month began with a series of storms over the summer rainfall region during the first 10 days. Much of the rainfall was confined to the western parts of North West, Gauteng and the central parts of Mpumalanga, with several areas experiencing localized flooding. The areas that received less rainfall as compared to November 2019 include the Lowveld and Bushveld of Limpopo and northern KwaZulu-Natal. These areas also recorded below-normal rainfall as compared to the long-term average for the month of December. Parts of the drought stricken Northern Cape, including the eastern Karoo, also received some welcome rainfall following the previous dry months. On the 5th the Upington and Springbok areas recorded totals of 39 and 22 mm, respectively.

The last few days of the month were characterized by isolated to severe thunder-storms, occurring frequently over the central and southern parts of the Free State, North West and the coastline of KwaZulu-Natal. Parts of the winter rainfall region received above-normal rainfall during December, whilst the all-year rainfall region received mostly below-normal rainfall.

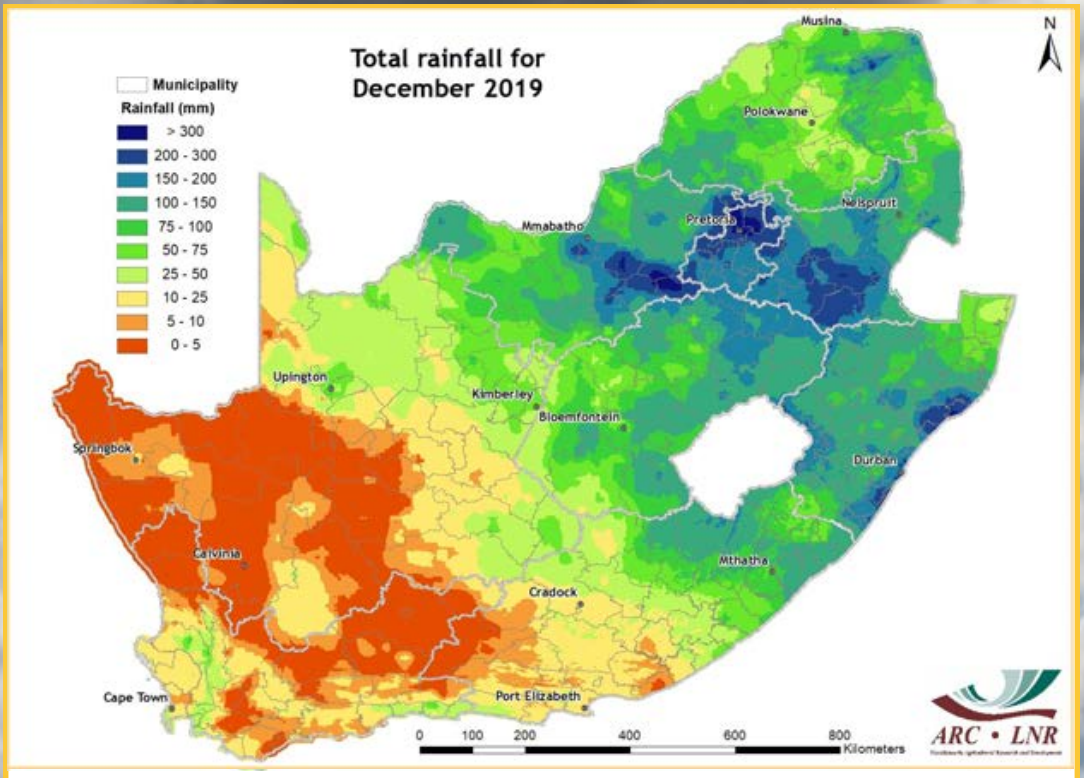


Figure 1

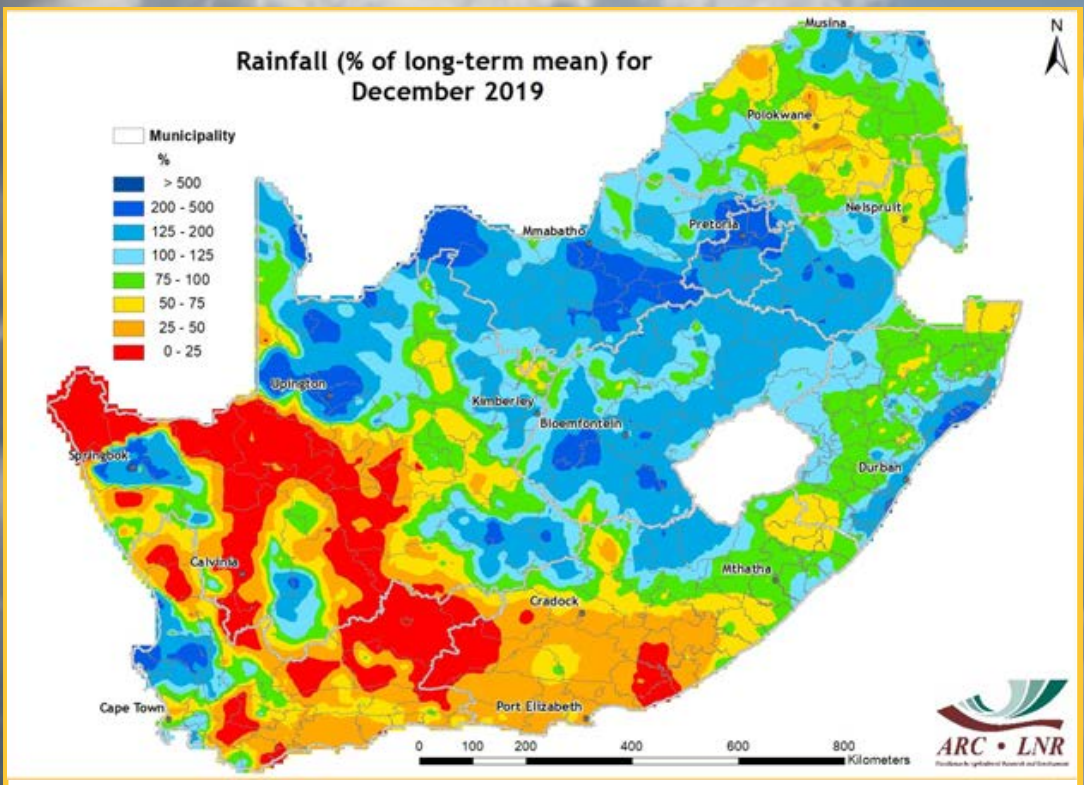
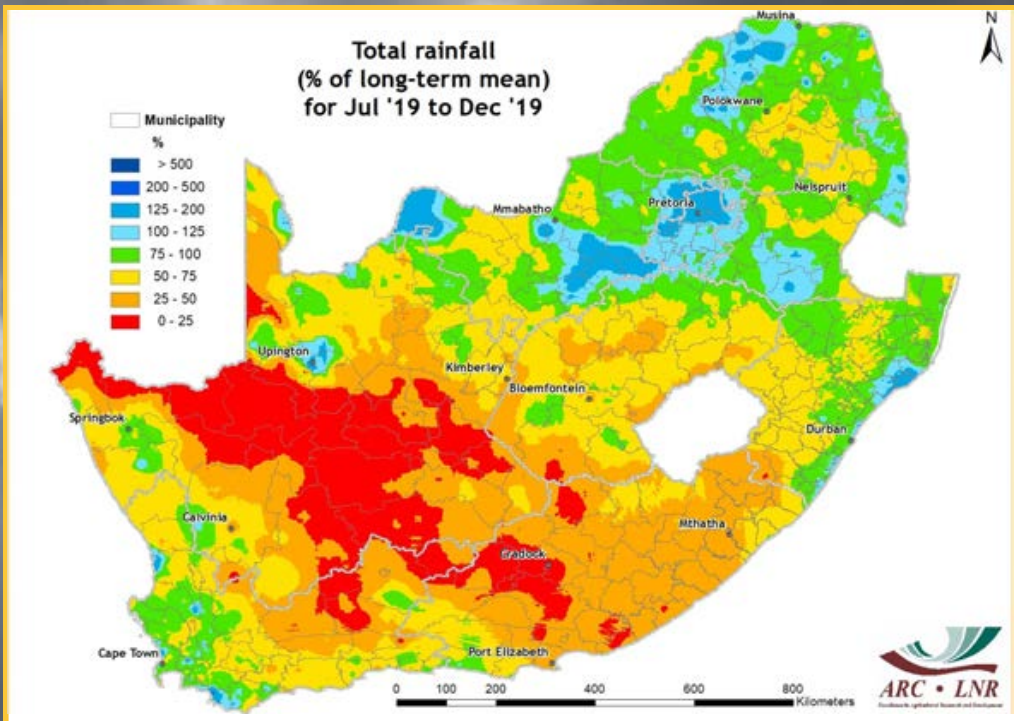


Figure 2



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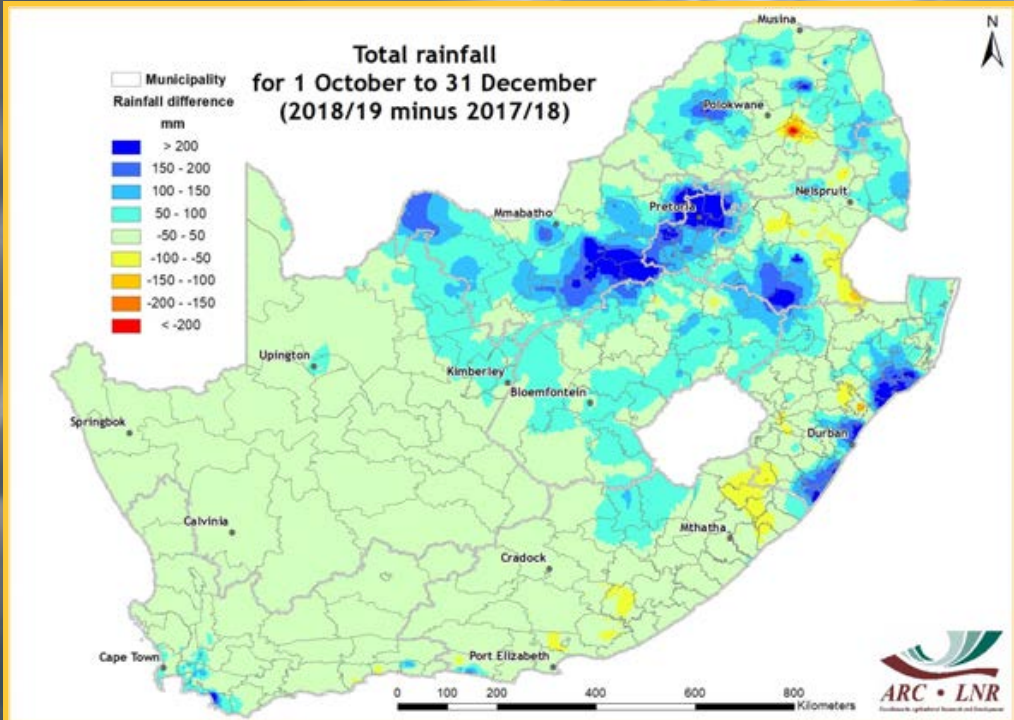

Figure 4

Figure 1:
Rainfall totals continued to increase in December over the summer rainfall region, as climatologically expected. Most rainfall activity was experienced over the eastern half of the country. Much of the Northern Cape and the Karoo remained dry, with no prospects of significant rainfall.

Figure 2:
Parts of the winter rainfall region, the central interior and the KwaZulu-Natal coast indicated above-normal rainfall conditions, expressed as a percentage of the long-term mean for the month of December. This has positive implications for agricultural productivity, particularly in the summer rainfall region. However, greater parts of Limpopo, the KZN midlands and the Eastern Cape experienced near- to below-normal rainfall, raising concerns with regard to farming activities.

Figure 3:
The map shows cumulative total rainfall for the latter half of 2019 (July to December) expressed as a percentage of the long-term mean for the same period. It is evident that most parts of the country experienced below-normal rainfall, with above-normal rainfall conditions detected over isolated parts of the North West, Gauteng, Limpopo, Mpumalanga and KwaZulu-Natal provinces.

Figure 4:
Much of the summer rainfall region received significantly more rain in October-December 2019 as compared to the same period last year. This could imply a plausible increase in production of agricultural summer commodities compared to the 2018 harvest. The rest of the country received around the same amounts of rainfall as compared to the previous year.

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2. Standardized Precipitation Index

Standardized Precipitation Index

The Standardized Precipitation Index (SPI - McKee *et al.*, 1993) was developed to monitor the occurrence of droughts from rainfall data. The index quantifies precipitation deficits on different time scales and therefore also drought severity. It provides an indication of rainfall conditions per quaternary catchment (in this case) based on the historical distribution of rainfall.

REFERENCE:
McKee TB, Doesken NJ and Kliest J (1993) The relationship of drought frequency and duration to time scales. In: Proceedings of the 8th Conference on Applied Climatology, 17-22 January, Anaheim, CA. American Meteorological Society: Boston, MA; 179-184.

The SPI maps revealing drought for medium- and long-term conditions are shown in Figures 5-8. Given the medium drought conditions for the month of December, it is evident that extreme drought (SPI ≤ -2) had been dominating the Northern Cape and Eastern Cape provinces. The Free State and the northern parts of North West (Dr Ruth Segomotsi Mompati district in particular) experienced some relief from the drought as compared to the 6-month SPI of November. Wet conditions were observed over Gauteng and the adjacent areas of North West, mainly due to the high volumes of rainfall received in December. The long-term SPI maps (24- to 36-month time scales) indicate similar observations as compared to November, implying that much of the Northern Cape, Eastern Cape, and parts of the Western Cape are still under severe to extreme drought stress.

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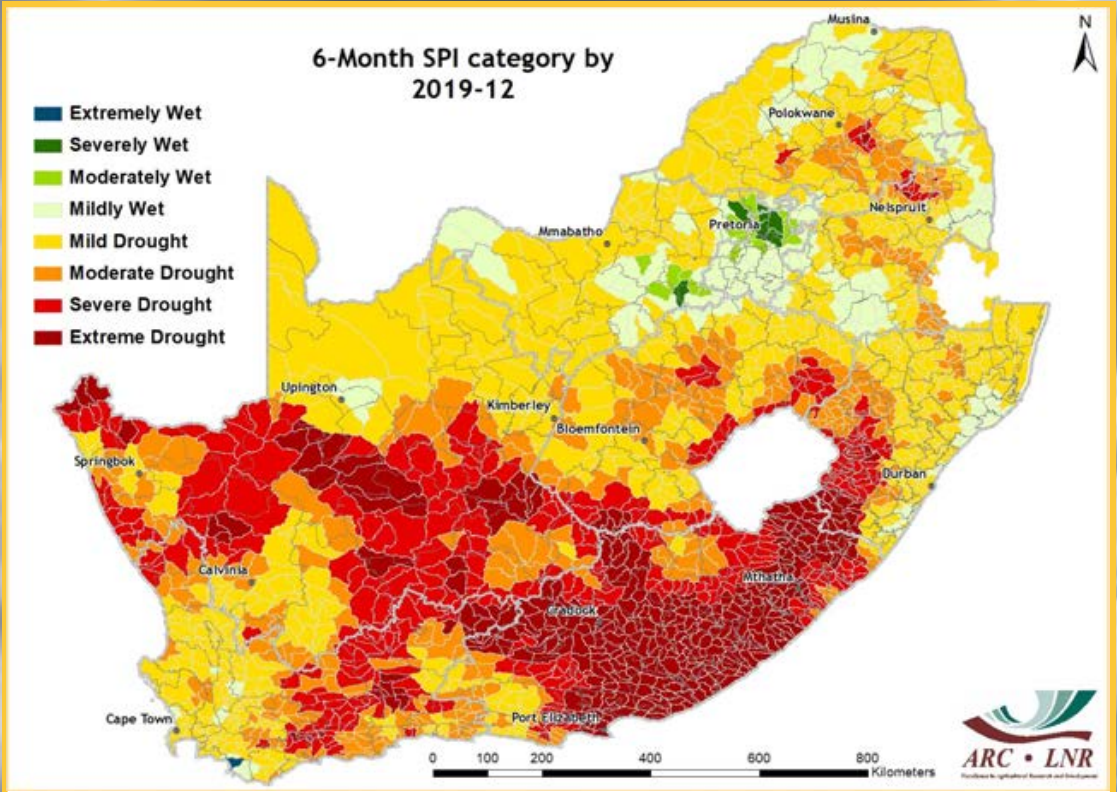

Figure 5

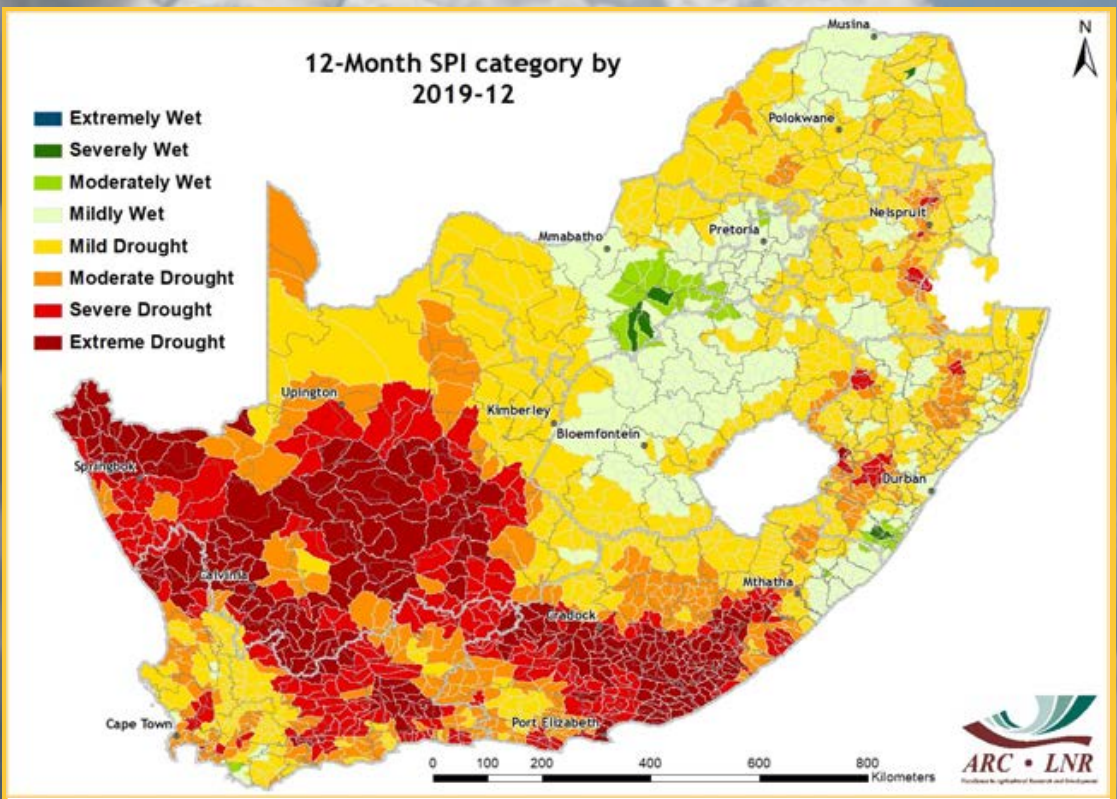

Figure 6

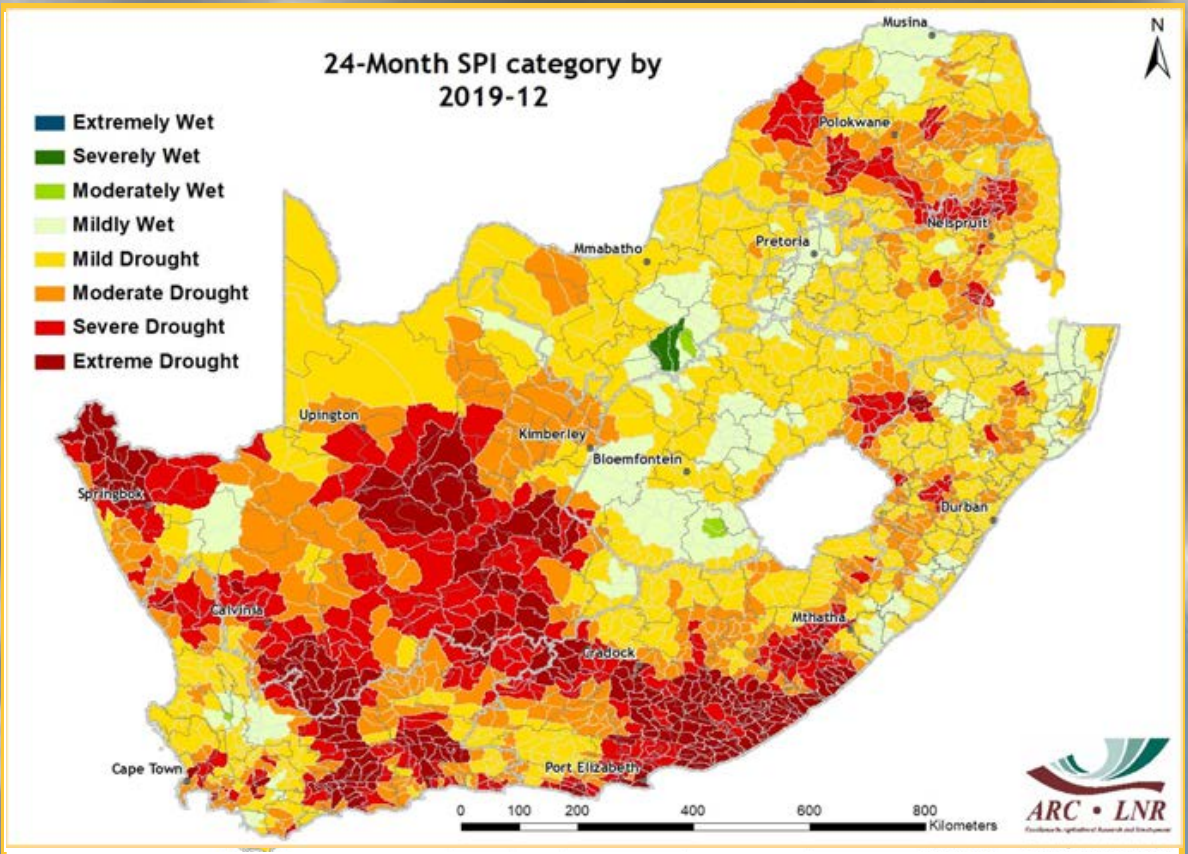

Figure 7

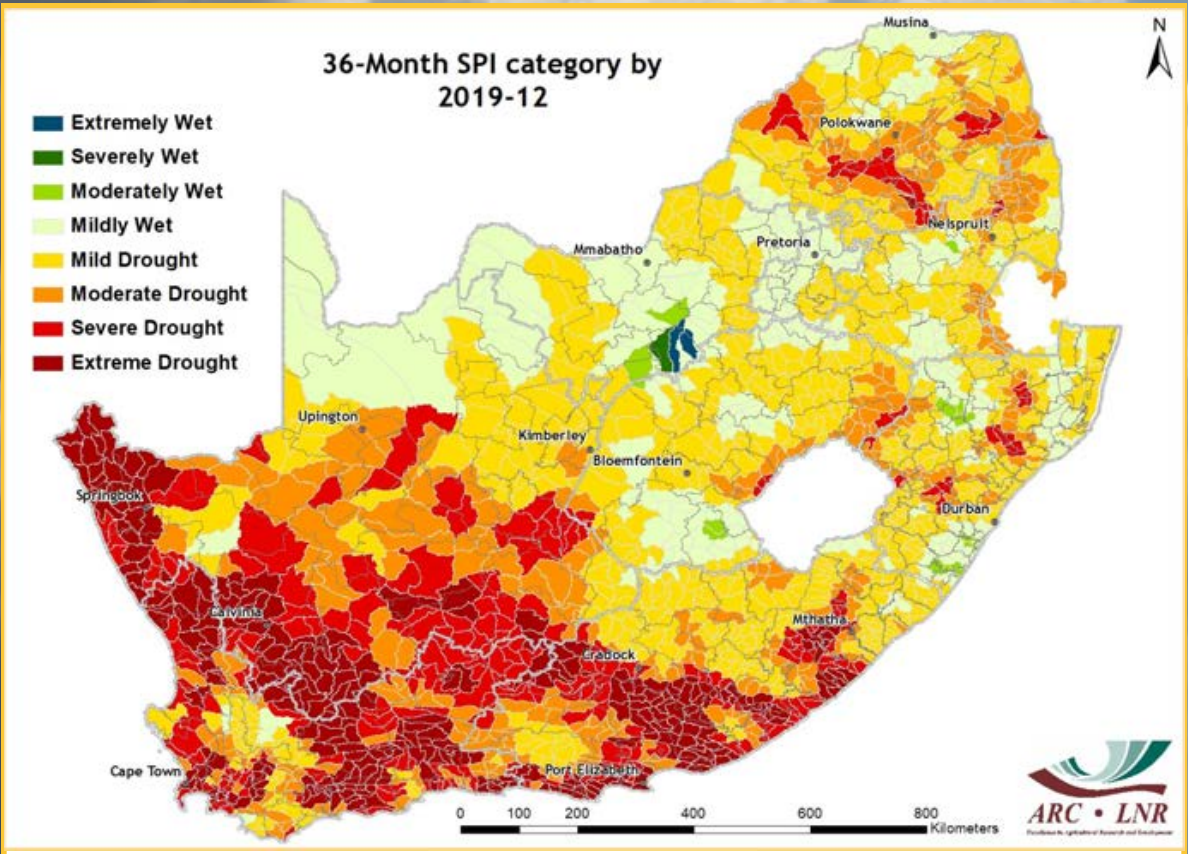

Figure 8

3. Rainfall Deciles

Deciles are used to express the ranking of rainfall for a specific period in terms of the historical time series. In the map, a value of 5 represents the median value for the time series. A value of 1 refers to the rainfall being as low or lower than experienced in the driest 10% of a particular month historically (even possibly the lowest on record for some areas), while a value of 10 represents rainfall as high as the value recorded only in the wettest 10% of the same period in the past (or even the highest on record). It therefore adds a measure of significance to the rainfall deviation.

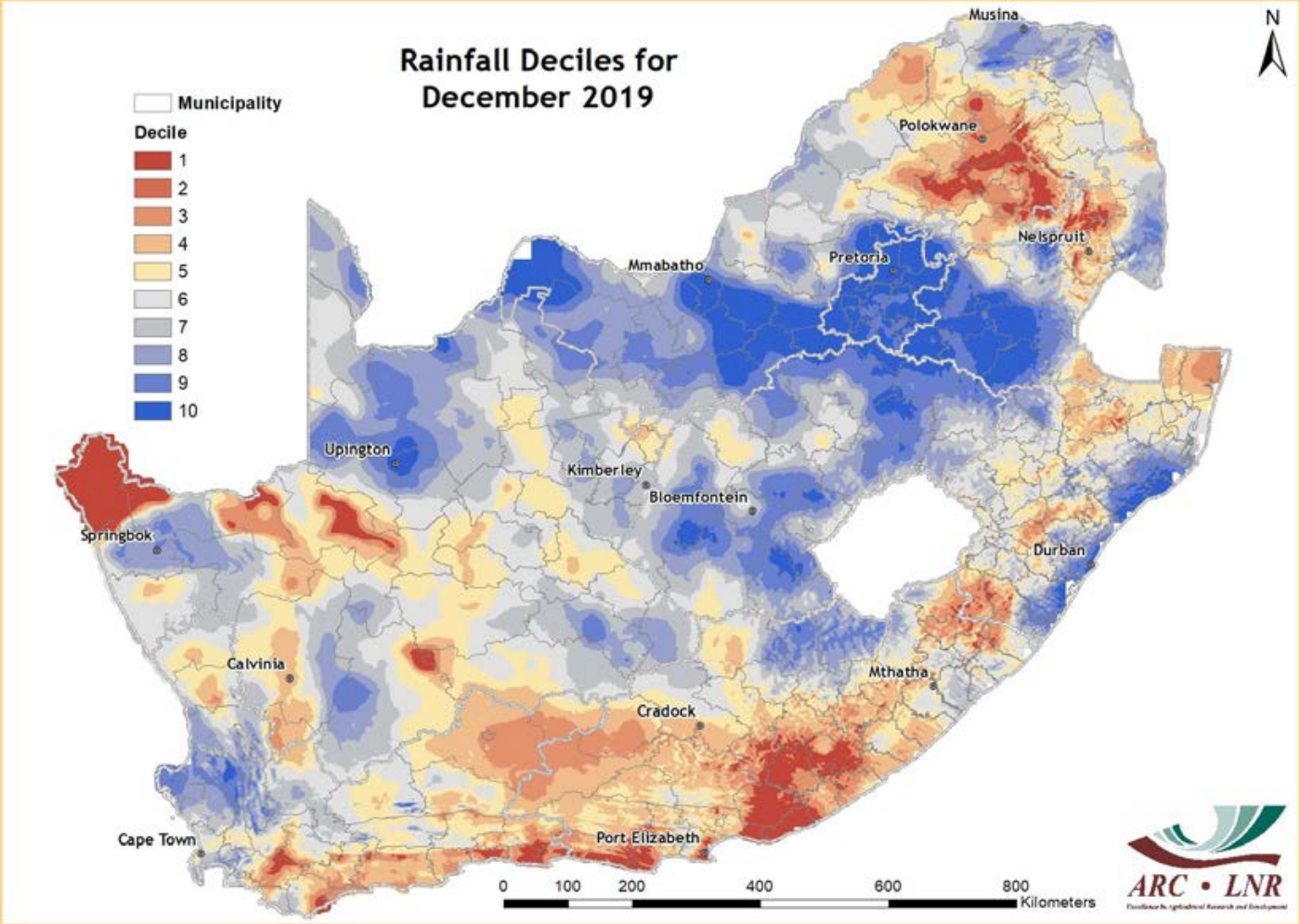

Figure 9

Figure 9:
Rainfall totals during December 2019 over the southwestern and most parts of the summer rainfall region (Gauteng, North West, KwaZulu-Natal, Mpumalanga and Free State provinces) compare well with the historically wet December months. The Namaqualand, Karoo, south coast towards KwaZulu-Natal, and the Limpopo Bushveld experienced a dry month compared to historical December rainfall totals.

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4. Vegetation Conditions

Vegetation Mapping

The Normalized Difference Vegetation Index (NDVI) is computed from the equation:

NDVI=(IR-R)/(IR+R)

where:
IR = Infrared reflectance &
R = Red band

NDVI images describe the vegetation activity. A decadal NDVI image shows the highest possible "greenness" values that have been measured during a 10-day period.

Vegetated areas will generally yield high values because of their relatively high near infrared reflectance and low visible reflectance. For better interpretation and understanding of the NDVI images, a temporal image difference approach for change detection is used.

The Standardized Difference Vegetation Index (SDVI) is the standardized anomaly (according to the specific time of the year) of the NDVI.

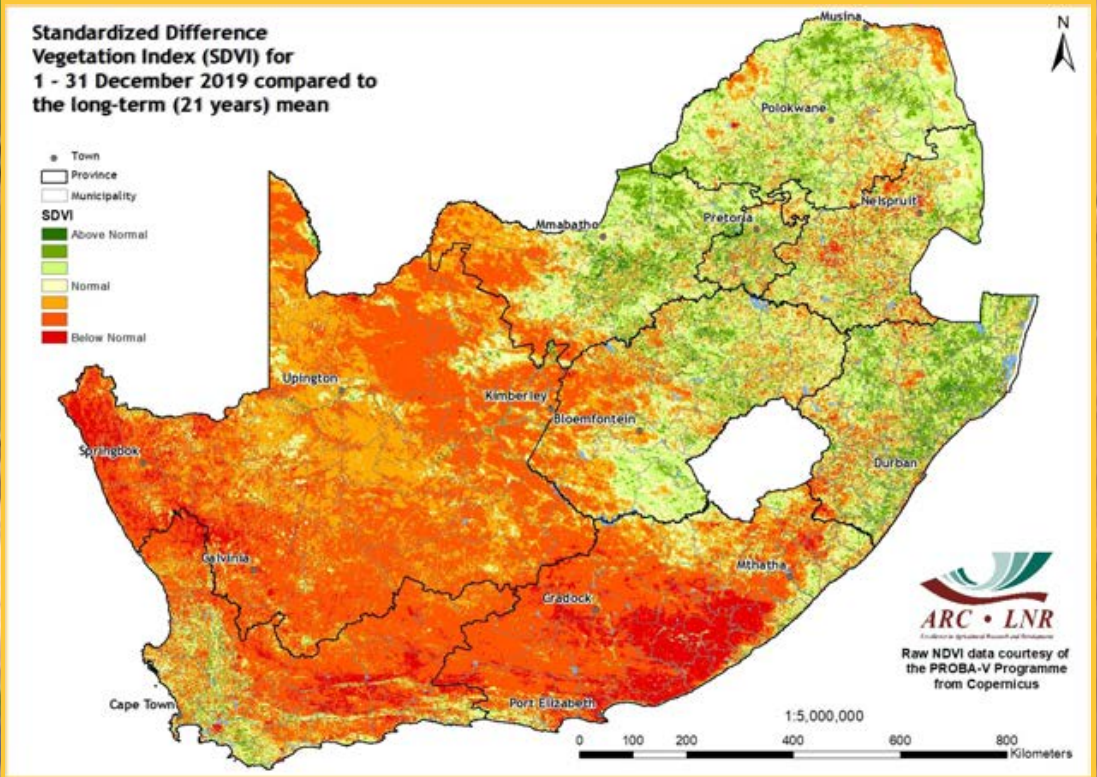

Figure 10

Figure 10:
The SDVI map for December shows that the central and northern parts of the country continue to experience above -normal vegetation activity. However, the western parts continue to experience poor vegetation conditions.

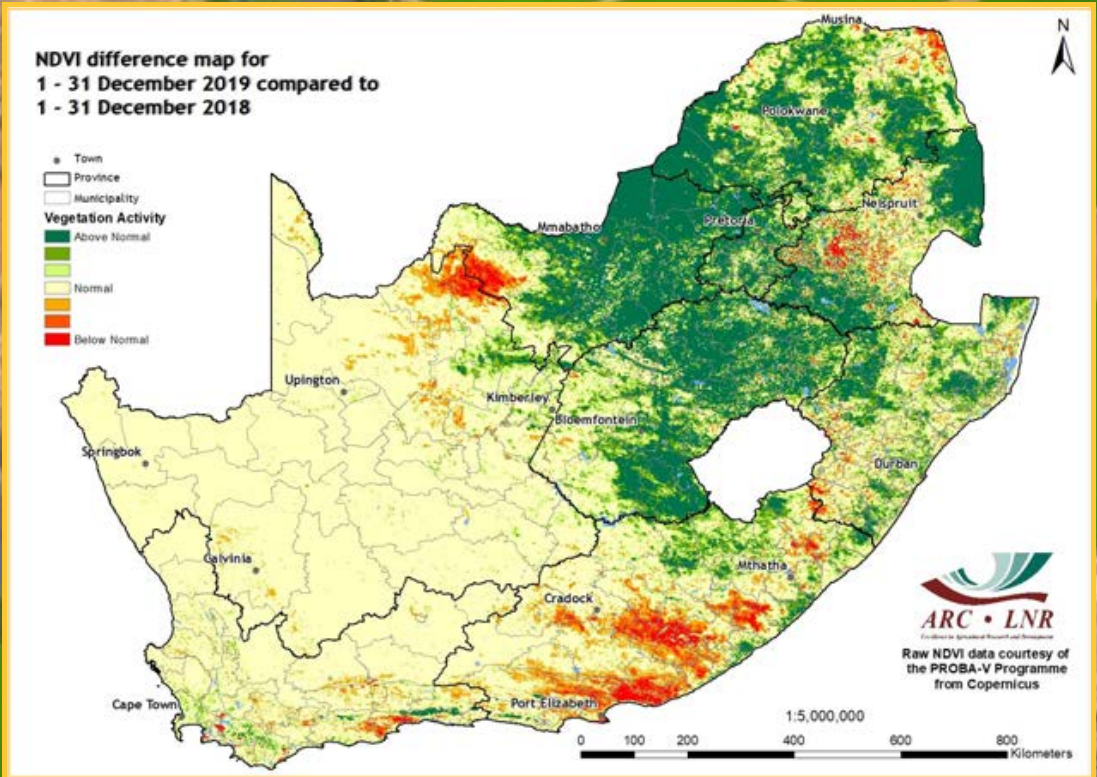

Figure 11

Figure 11:
Compared to the same period last year, the NDVI difference map for December shows that the northern parts experienced above-normal vegetation conditions, while the remainder of the country continues to experience normal vegetation activity. Some isolated areas in the Eastern Cape, North West, Mpumalanga and Limpopo experienced below-normal vegetation activity.

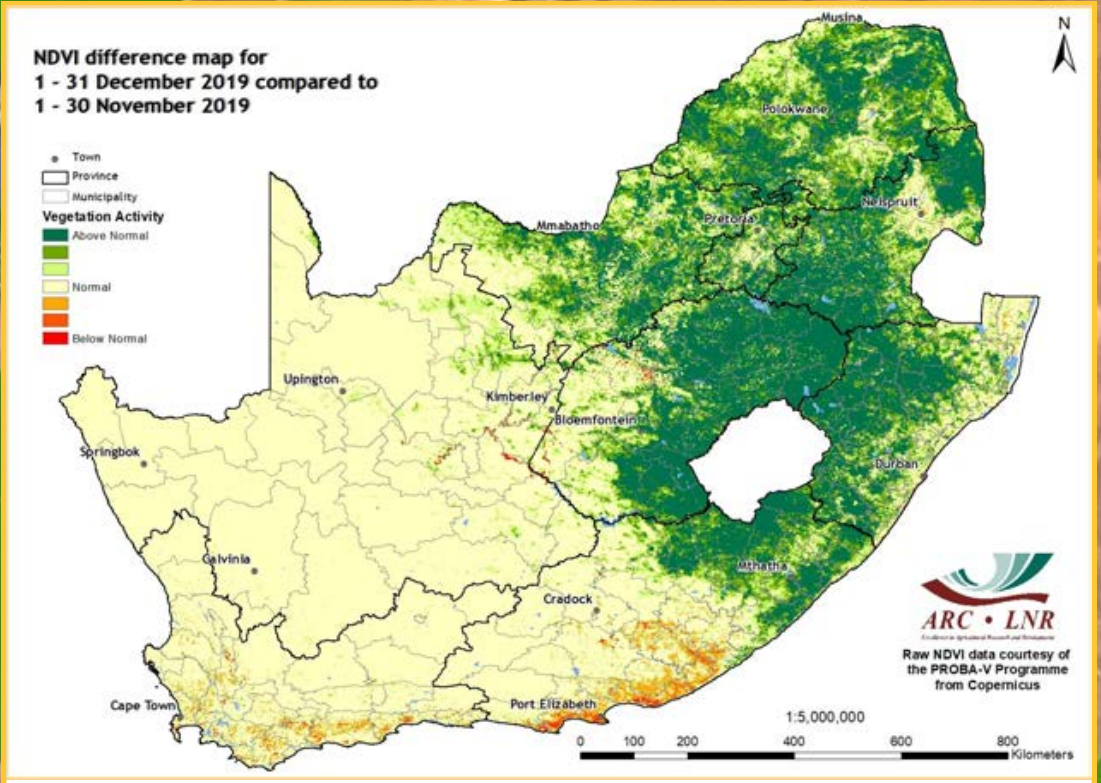

Figure 12

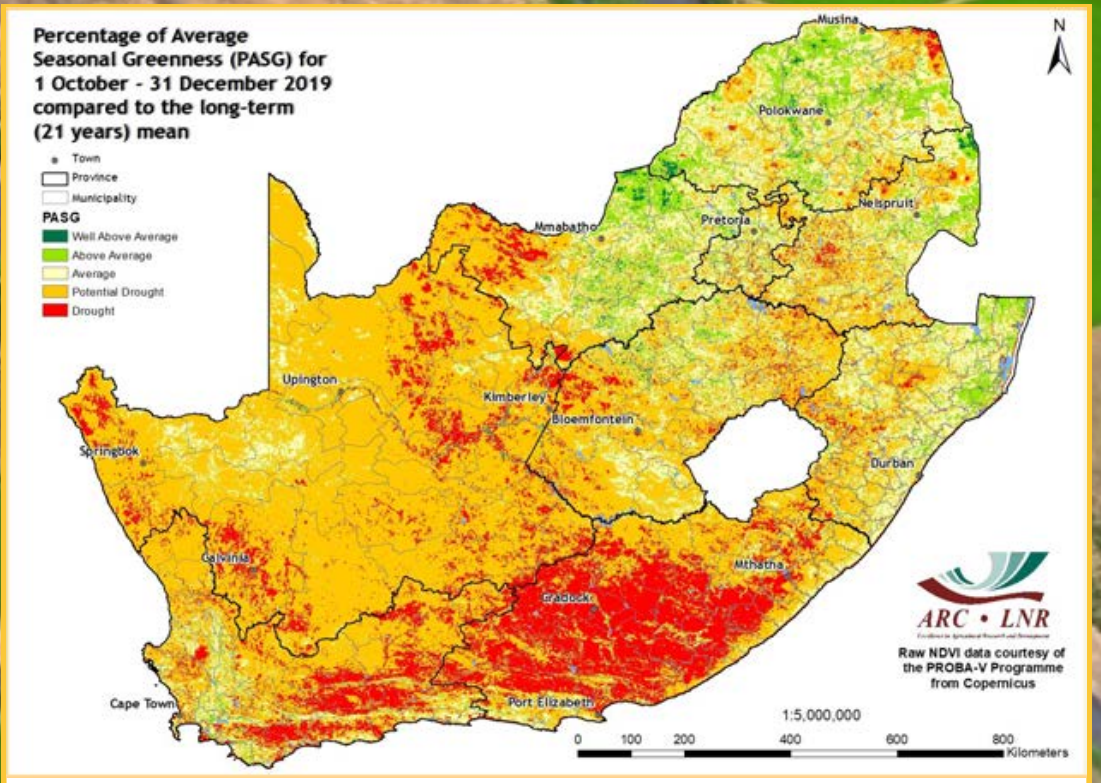

Figure 13

Vegetation Mapping
(continued from p. 7)

Interpretation of map legend

NDVI-based values range between 0 and 1. These values are incorporated in the legend of the difference maps, ranging from -1 (lower vegetation activity) to 1 (higher vegetation activity) with 0 indicating normal/the same vegetation activity or no significant difference between the images.

Cumulative NDVI maps:

Two cumulative NDVI datasets have been created for drought monitoring purposes:

Winter: January to December
Summer: July to June

Figure 12:
Compared to the previous month, the December NDVI map shows that the eastern half of the country experienced above-normal vegetation activity while the western half experienced normal activity. A notable exception is the far western parts of the Western Cape and far southern parts of the Eastern Cape which experienced poor vegetation conditions.

Figure 13:
The PASG map over a 3-month period compared to the long-term mean shows that much of the country experienced potential drought while the Eastern Cape experienced drought. However, isolated parts of the Free State, North West, Limpopo, KZN and Mpumalanga experienced average to above-average vegetation greenness.

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5. Vegetation Condition Index

Vegetation Condition Index (VCI)

The VCI is an indicator of the vigour of the vegetation cover as a function of the NDVI minimum and maximum encountered for a specific pixel and for a specific period, calculated over many years.

The VCI normalizes the NDVI according to its changeability over many years and results in a consistent index for various land cover types. It is an effort to split the short-term weather-related signal from the long-term climatological signal as reflected by the vegetation. The VCI is a better indicator of water stress than the NDVI.

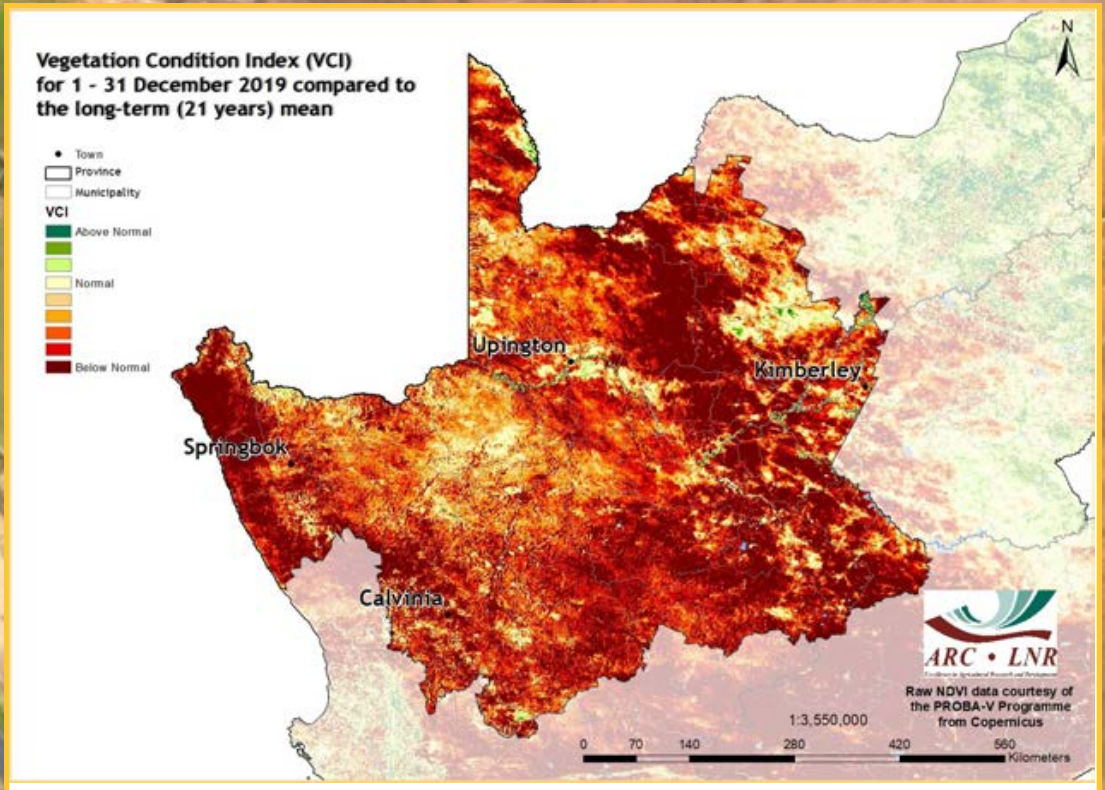

Figure 14

Figure 14:
The VCI map for December indicates that severe drought conditions continue to impact negatively on vegetation activity in the Northern Cape.

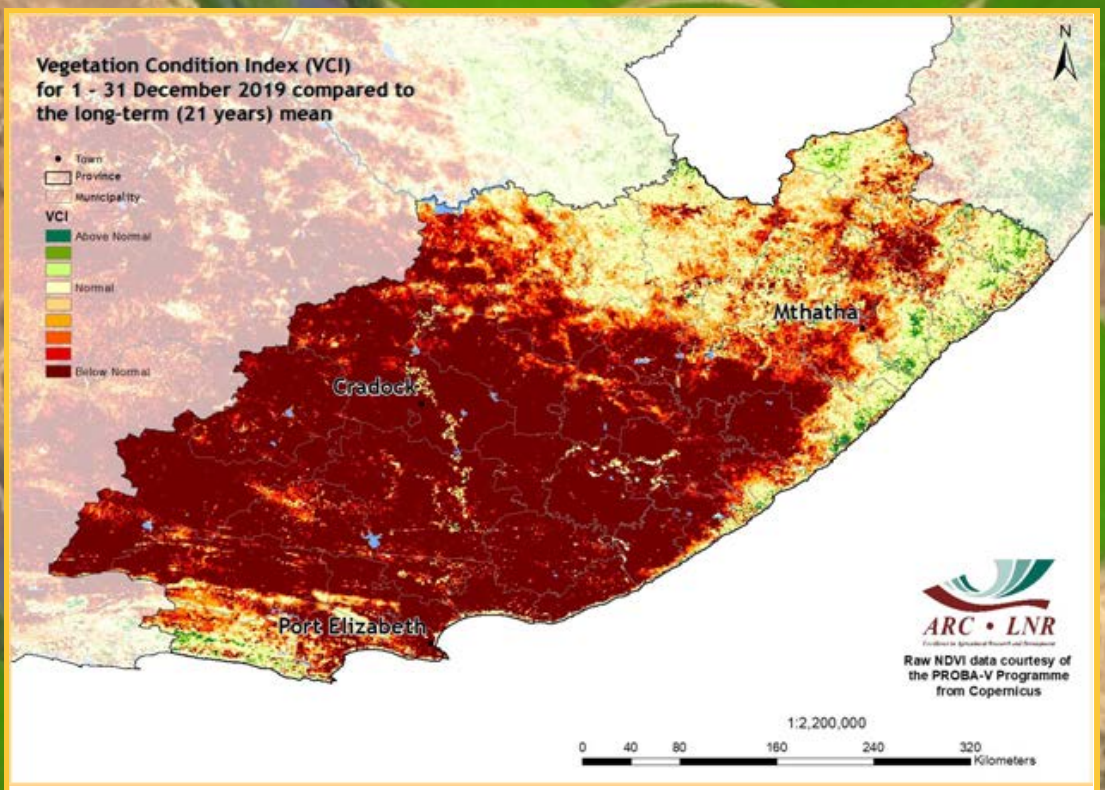

Figure 15

Figure 15:
The VCI map for December indicates that, compared to the long-term average, many parts of the Eastern Cape continue to experience poor vegetation activity. Minor exceptions can be observed in the northeastern parts of the province.

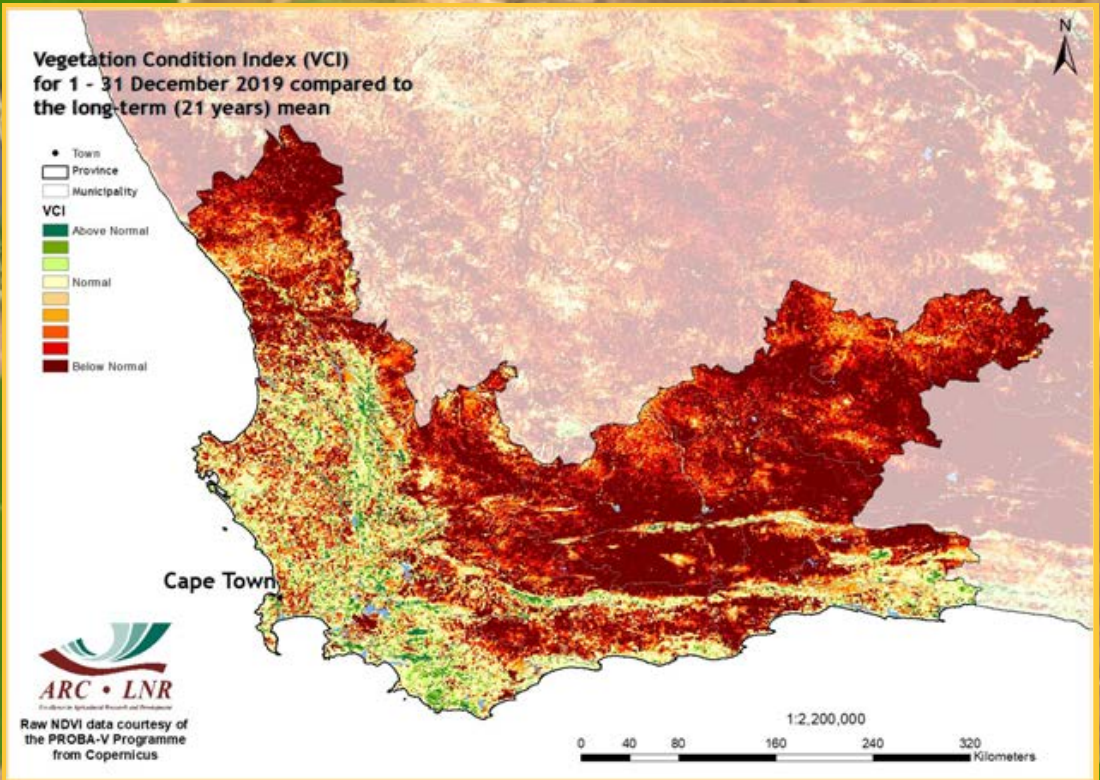

Figure 16

Figure 16:
The VCI map for December indicates that many parts of the Western Cape continue to experience poor vegetation conditions, particularly the Central Karoo, northern parts of the West Coast, as well as northeastern and western parts of the Eden District Municipality. Minor exceptions can be observed in isolated areas in the western parts of the province.

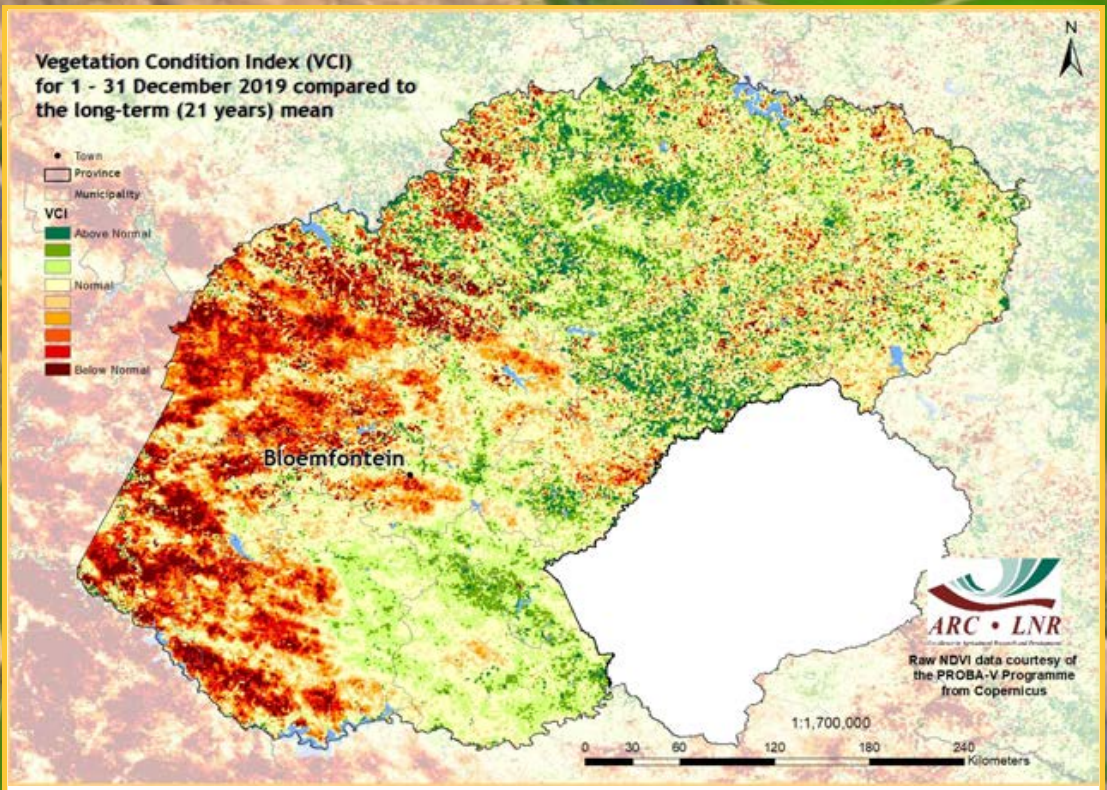

Figure 17

Figure 17:
The VCI map for December indicates that the western parts of the Free State experienced poor vegetation activity while the eastern parts of the province experienced above-normal vegetation conditions.

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6. Vegetation Conditions & Rainfall

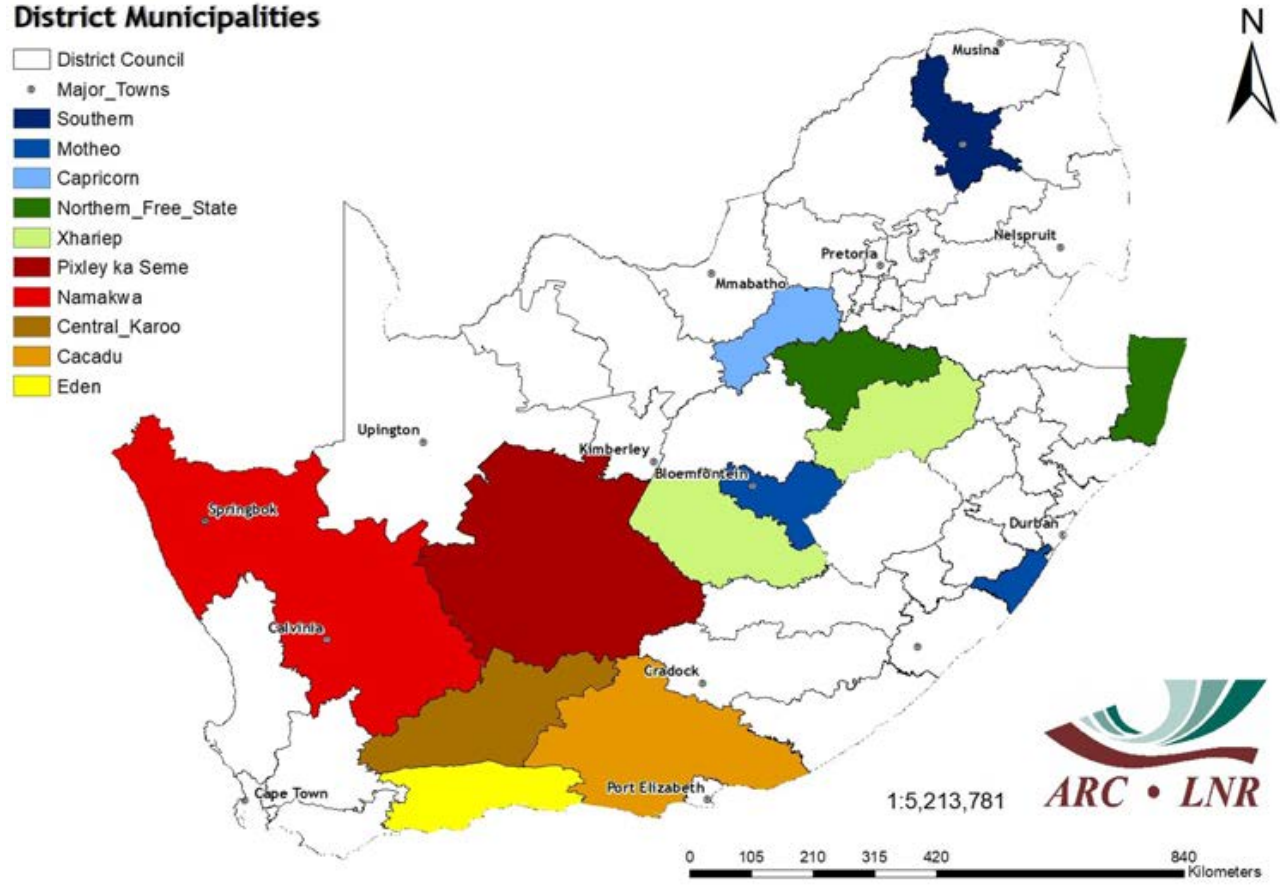

Figure 18

Rainfall and NDVI Graphs

Figure 18:
Orientation map showing the areas of interest for December 2019. The district colour matches the border of the corresponding graph.

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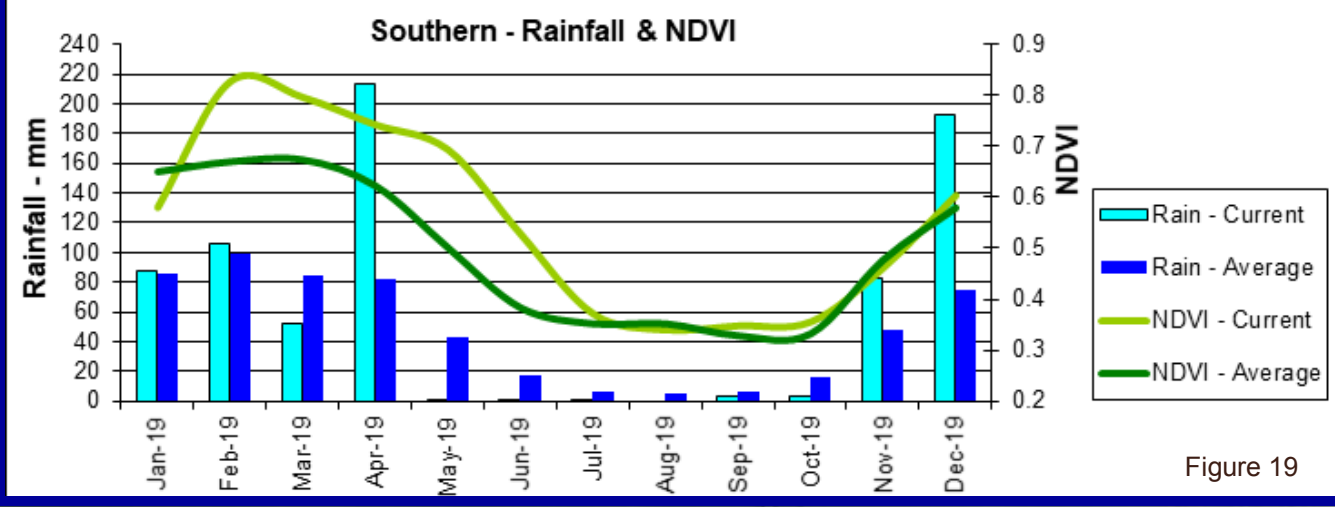
Figures 19-23:
Indicate areas with higher cumulative vegetation activity for the last year.

Figures 24-28:
Indicate areas with lower cumulative vegetation activity for the last year.



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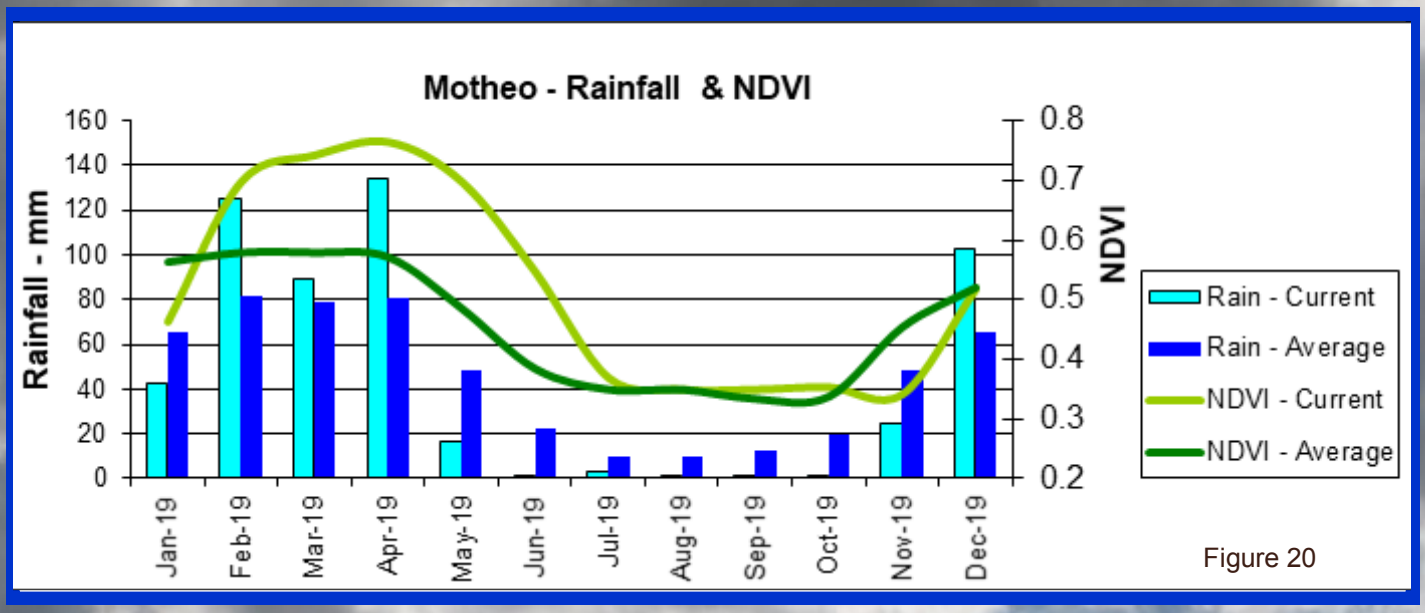

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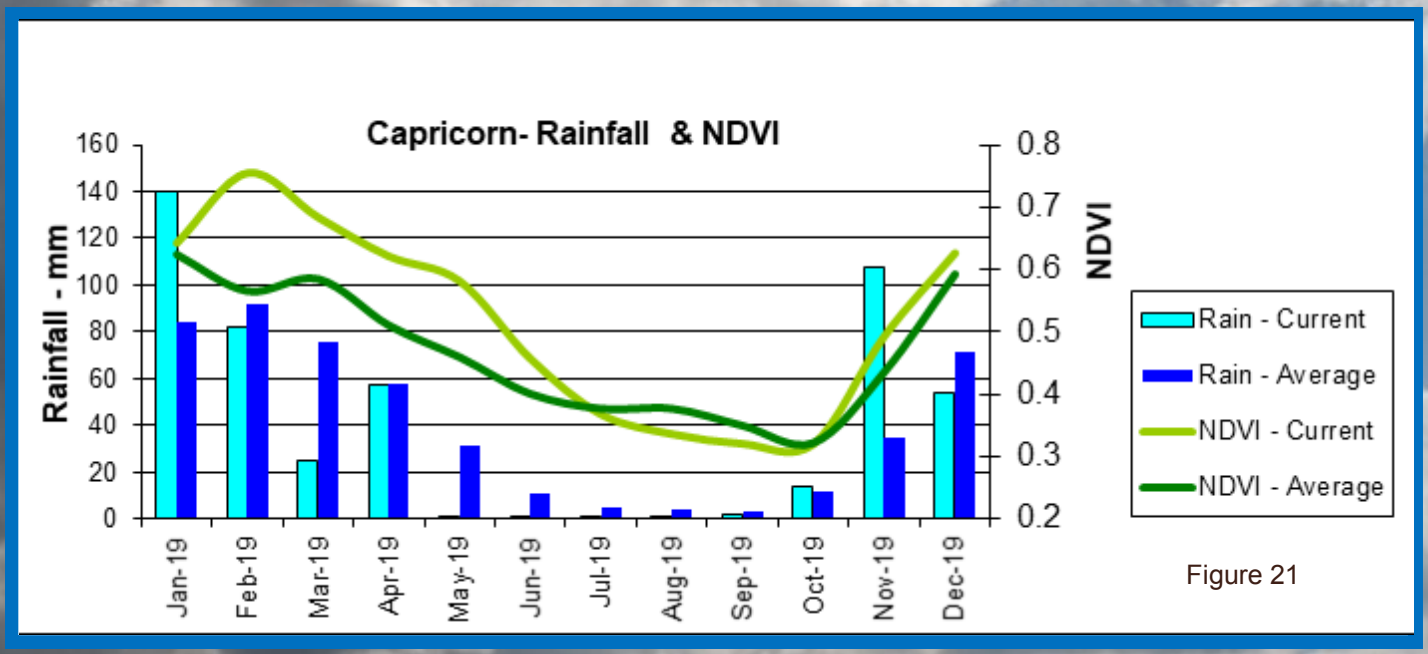

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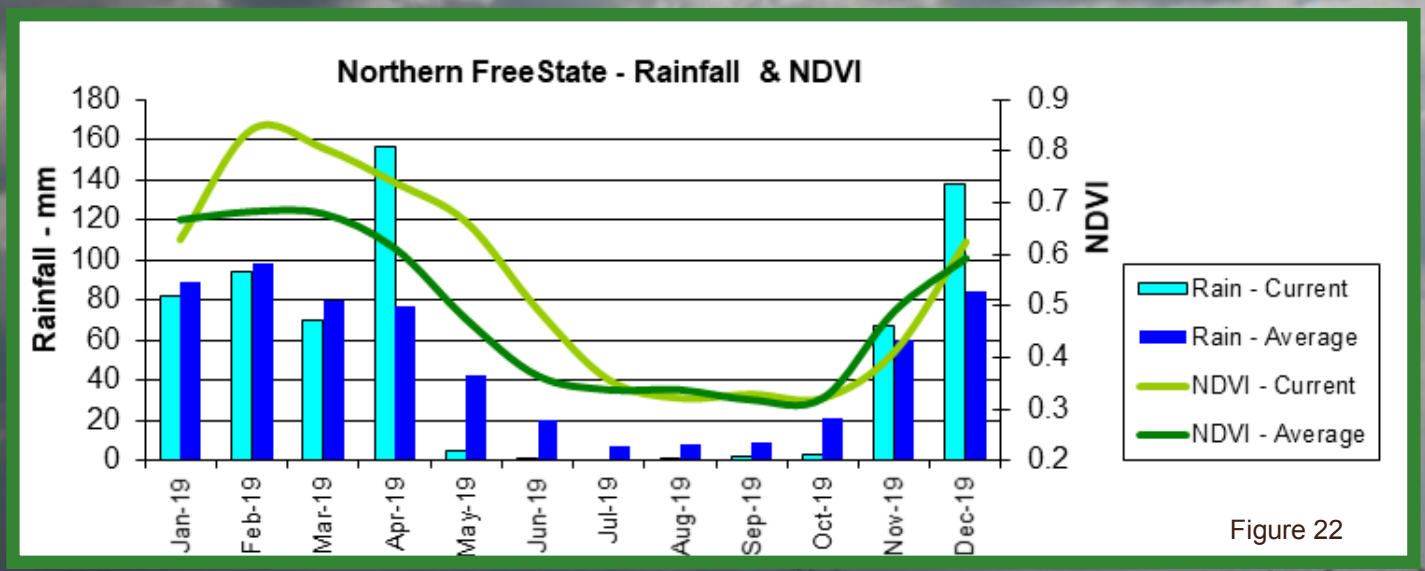

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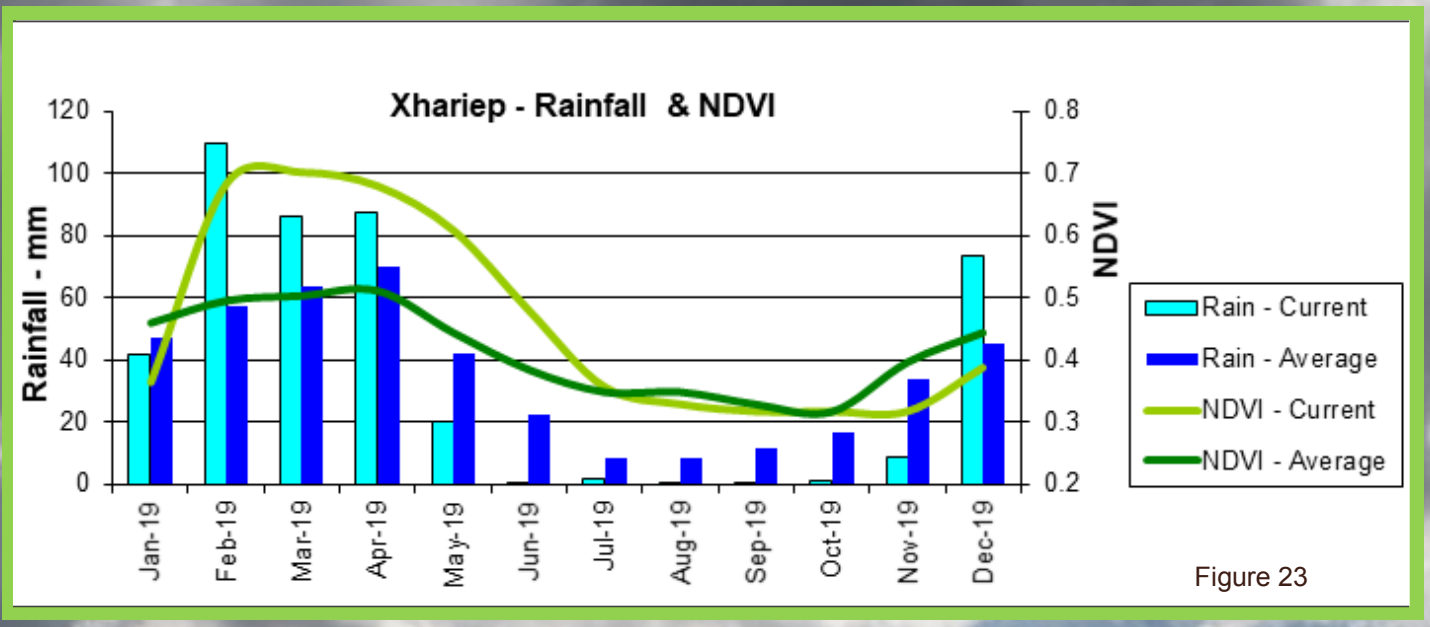

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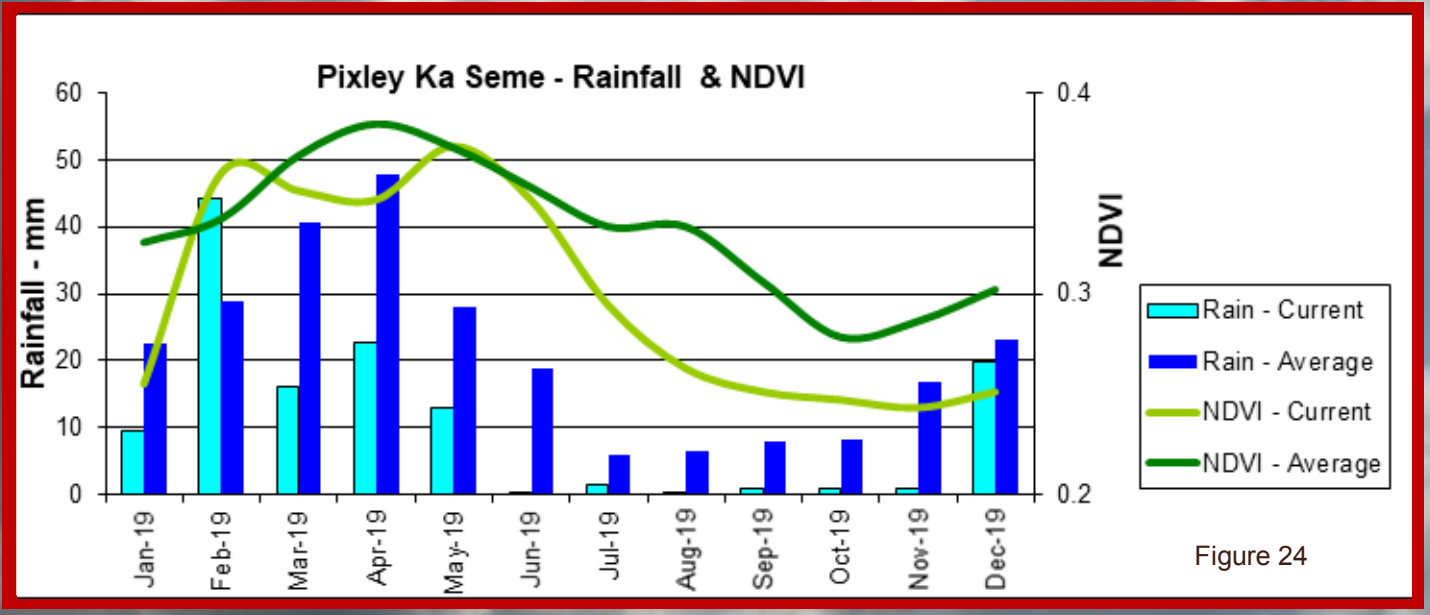

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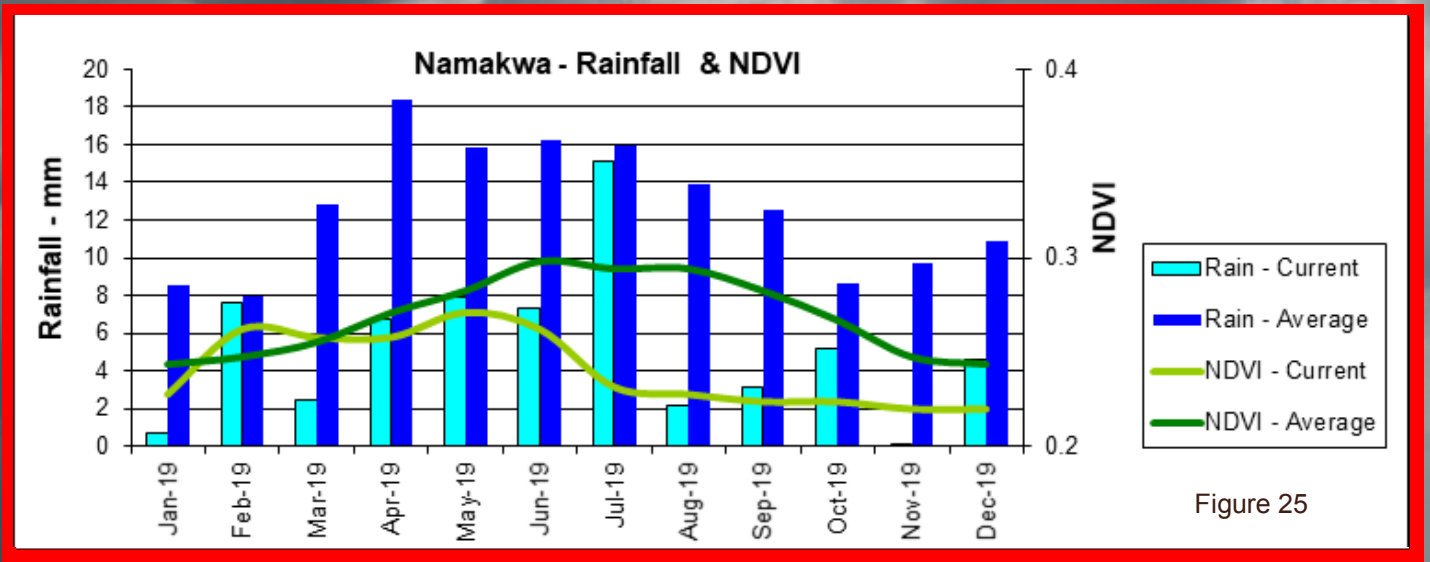

Figure 25

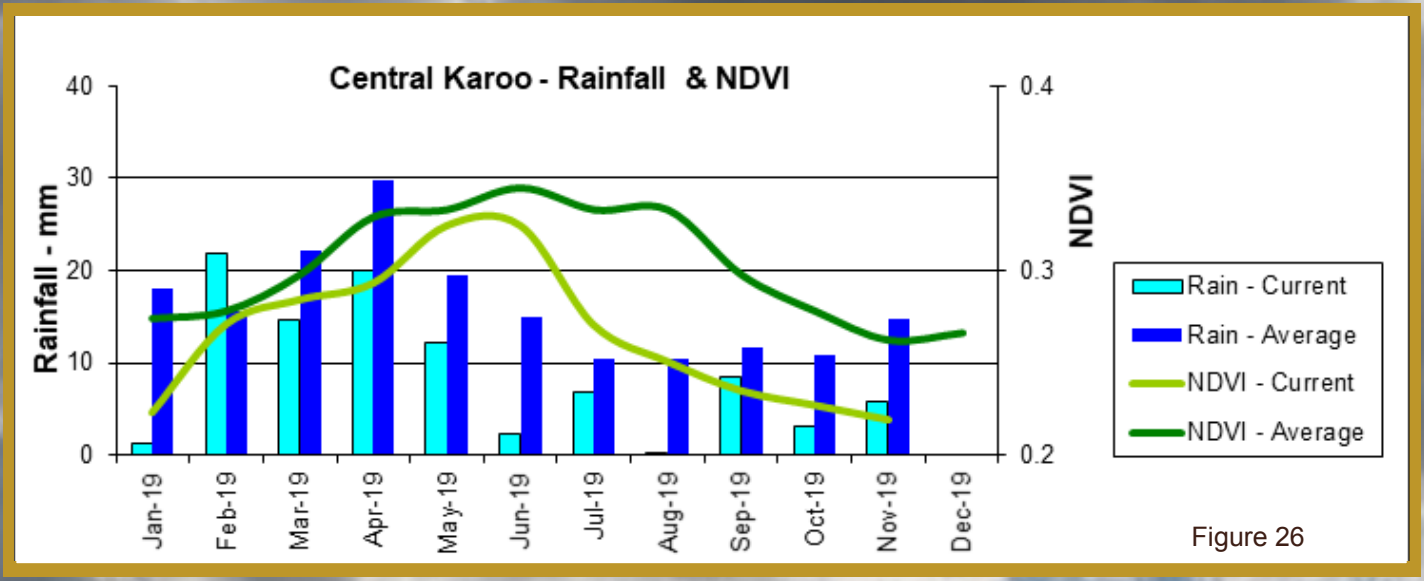

Figure 26

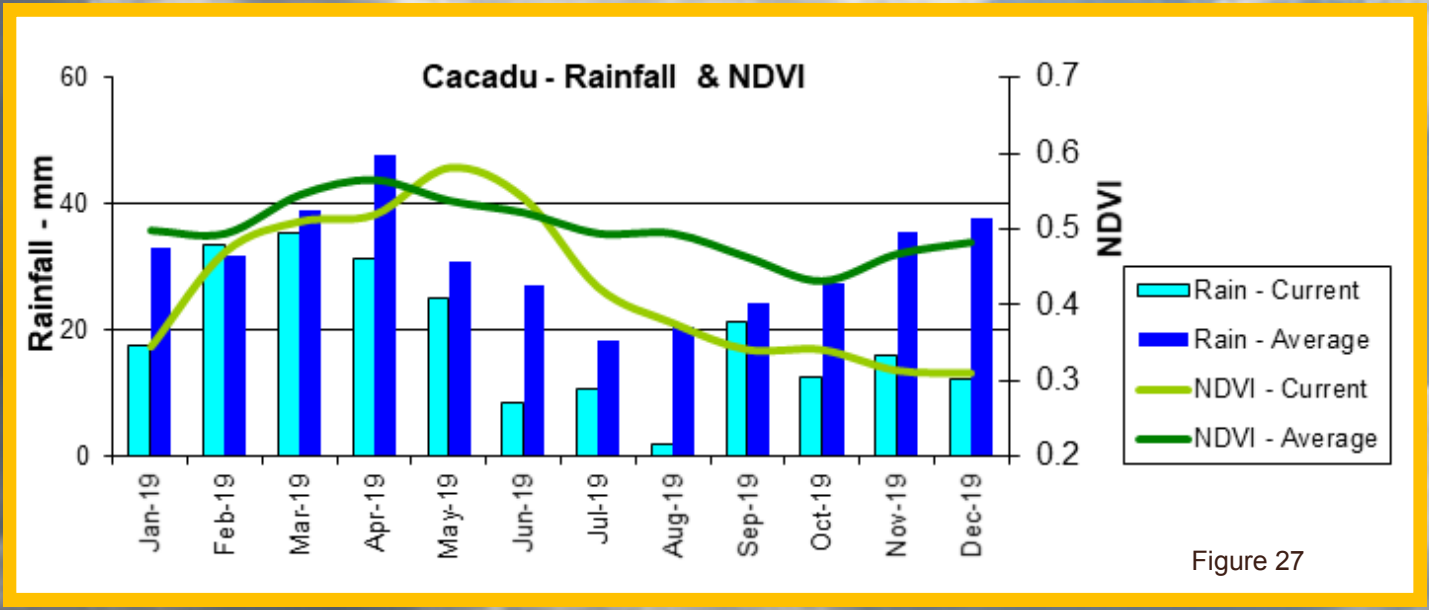

Figure 27

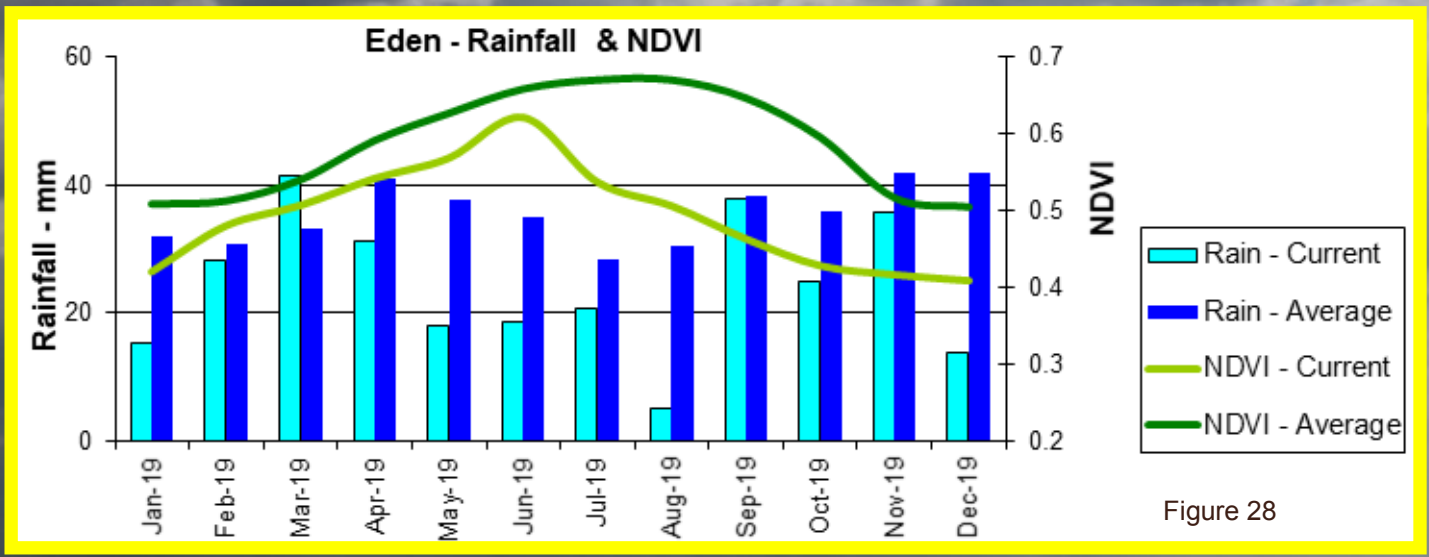

Figure 28

7. Fire Watch

Active Fires *(Provided when data is available)*

Forest and vegetation fires have temperatures in the range of 500 K (Kelvin) to 1000 K. According to Wien's Displacement Law, the peak emission of radiance for blackbody surfaces of such temperatures is at around 4 µm. For an ambient temperature of 290 K, the peak of radiance emission is located at approximately 11 µm. Active fire detection algorithms from remote sensing use this behaviour to detect "hot spot" fires.

Figure 29:
The graph shows the total number of active fires detected between 11-31 December 2019 per province. Fire activity was higher in the Western Cape compared to the long-term average.

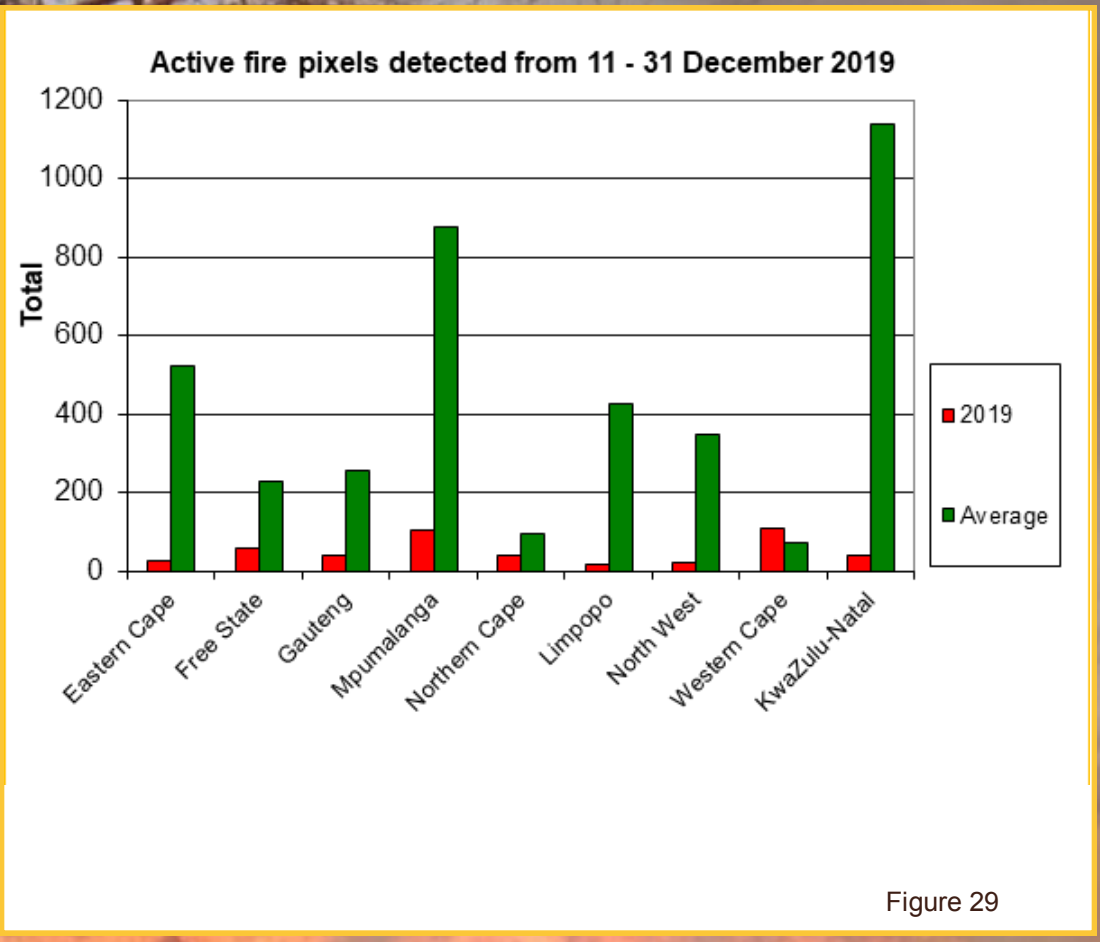

Figure 29

Figure 30:
The map shows the location of active fires detected between 11-31 December 2019.

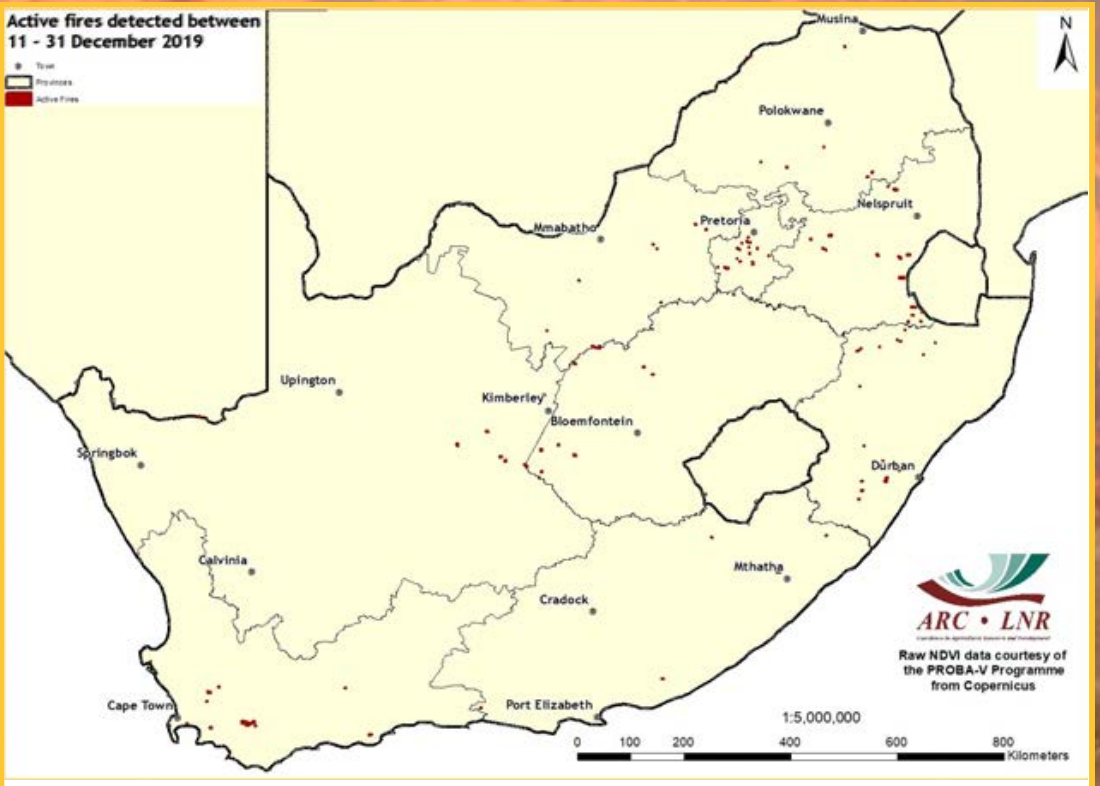

Figure 30

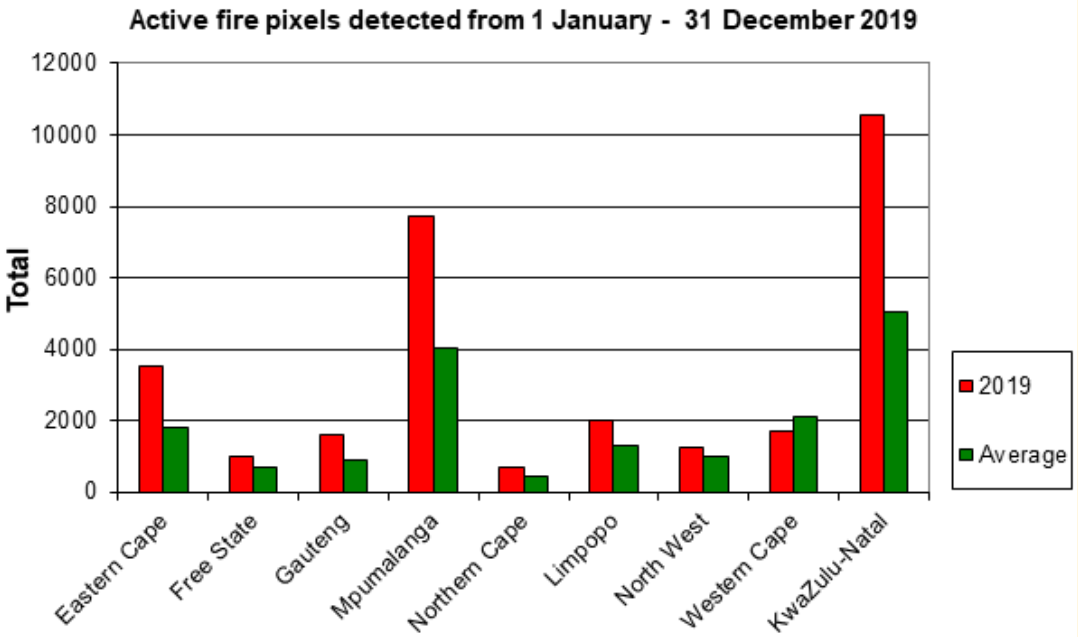

Figure 31

Figure 31:
The graph shows the total number of active fires detected between 1 January to 31 December 2019 per province. Fire activity was higher in all provinces except the Western Cape compared to the long-term average.

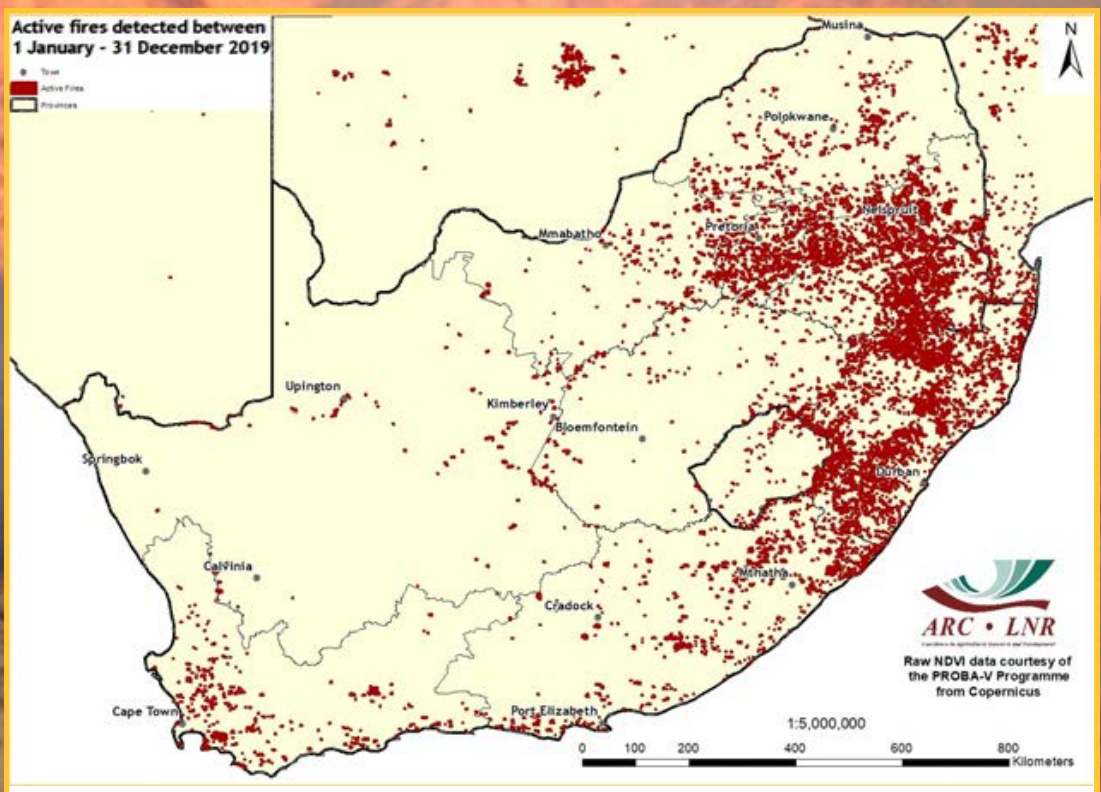

Figure 32

Figure 32:
The map shows the location of active fires detected between 1 January to 31 December 2019.

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8. Surface Water Resources

Countrywide surface water areas (SWAs) are mapped on a monthly basis by GeoTerraImage using Sentinel 2 satellite imagery from the start of its availability at the end of 2015.

Figure 33 shows a comparison between the area of water available now and the maximum area of surface water recorded in the last 3 years. Values less than 100 represent water catchments within which the current month's total surface water is less than the maximum extent recorded for the same area since the end of 2015. Figure 34 shows a comparison between the area of water available now and for the same month in 2018. On this map, values less than 100 represent water catchments within which the current month's total surface water is less than that recorded in the same water catchment, in the same month, in 2018.

The long-term map for December 2019 shows little change to the previous map for November, and again continues to show that the majority of water catchments across the country currently contain similar or slightly reduced surface water areas compared to the maximum recorded in the same catchment since the end of 2015.

Comparison between December 2019 and December 2018 continues to indicate that the majority of water catchments across the country are showing lower levels of surface water extent, with notable significant reductions in the Karoo and small local catchments in the Eastern Cape and KZN. The exceptions to this are the catchments bordering Botswana and Zimbabwe in Limpopo and North West provinces which are now showing significantly higher surface water areas as a result of good recent rains in these regions.

The SWA maps are derived from the monthly data generated and available through GeoTerraImage's 'Msanzi Amanzi' web information service: https://www.water-southafrica.co.za

Questions/Comments:

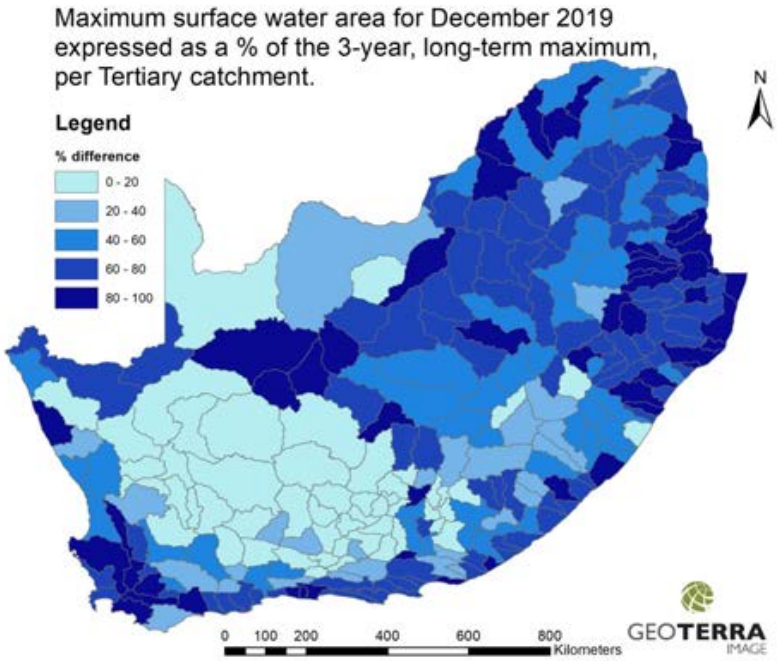

Figure 33

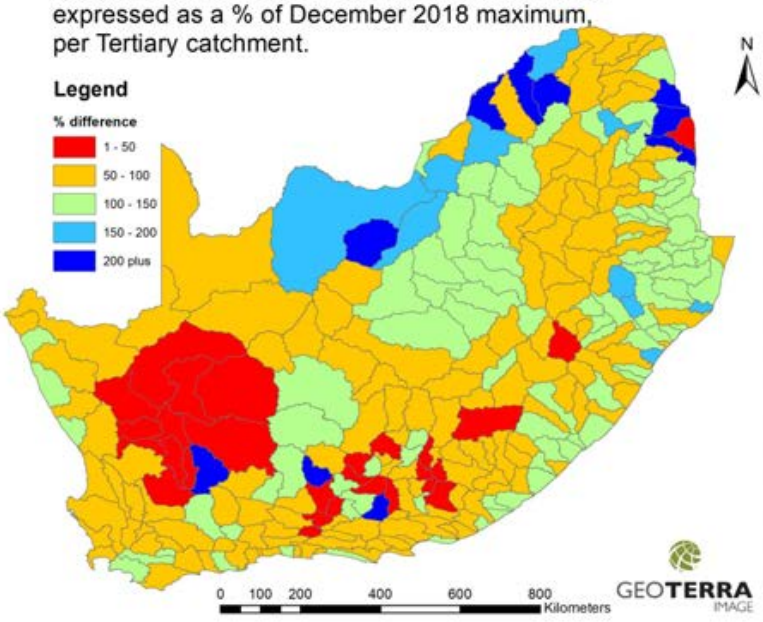

Figure 34

Agrometeorology

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The programme focuses on the use of weather and climate information and monitoring for the forecast and prediction of the weather elements that have direct relevance on agricultural planning and the protection of crop, forest and livestock. The Agro-Climate Network & Databank is maintained as a national asset.

FOCUS AREAS

Climate Monitoring, Analysis & Modelling

- Analysis of climate variability and climate model simulation
- Use of crop modelling to assess the impact of climate on agriculture
- Development of decision support tools for farmers

Climate Change Adaptation & Mitigation

- National greenhouse gas inventory in the agricultural sector
- Improvement of agricultural production technologies under climate change
- Adaptation and mitigation initiatives, e.g. biogas production in small-scale farming communities

Climate Information Dissemination

- Communication to farmers for alleviating weather-related disasters such as droughts
- Dissemination of information collected from weather stations
- Climate change awareness campaigns in farming communities

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Geoinformation Science

ARC • LNR

The programme focuses on applied Geographical Information Systems (GIS) and Earth Observation (EO)/Remote Sensing research and provides leadership in applied GIS products, solutions, and decision support systems for agriculture and natural resources management. The Coarse Resolution Satellite Image Archive and Information Database is maintained as a national asset.

FOCUS AREAS

Decision Support Systems

- Spatially explicit information dissemination systems, e.g. Umlindi newsletter
- Crop and land suitability modelling/assessments
- Disease and pest outbreaks and distribution modelling
- Precision agriculture information systems

Early Warning & Food Security

- Drought and vegetation production monitoring
- Crop estimates and yield modelling
- Animal biomass and grazing capacity mapping
- Global and local agricultural outlook forecasts
- Disaster monitoring for agricultural systems

Natural Resources Monitoring

- Land use/cover mapping
- Invasive species distribution
- Applications of GIS and EO on land degradation/erosion, desertification, hydrology and catchment areas
- Rangeland health assessments
- Carbon inventory monitoring

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The Coarse Resolution Imagery Database (CRID)

NOAA AVHRR

The ARC-ISCW has an archive of daily NOAA AVHRR data dating from 1985 to 2004. This database includes all 5 bands as well as the Normalized Difference Vegetation Index (NDVI), Active Fire and Land Surface Temperature (LST) images. The NOAA data are used, for example, for crop production and grazing capacity estimation.

MODIS

MODIS data is distributed by the Land Processes Distributed Active Archive Center (LP DAAC), located at the U.S. Geological Survey's EROS Data Center. The MODIS sensor is more advanced than NOAA with regard to its high spatial (250 m^2 to 1 km^2) and spectral resolution. The ARC-ISCW has an archive of MODIS (version 4 and 5) data.

- MODIS v4 from 2000 to 2006
- MODIS v5 from 2000 to present

Datasets include:

- MOD09 (Surface Reflectance)
- MOD11 (Land Surface Temperature)
- MOD13 (Vegetation Products)
- MOD14 (Active Fire)
- MOD15 (Leaf Area Index & Fraction of Photosynthetically Active Radiation
- MOD17 (Gross Primary Productivity)
- MCD43 (Albedo & Nadir Reflectance)
- MCD45 (Burn Scar)

Coverage for version 5 includes South Africa, Namibia, Botswana, Zimbabwe and Mozambique.
More information:
http://modis.gsfc.nasa.gov

VGT4AFRICA and GEOSUCCESS

SPOT NDVI data is provided courtesy of the VEGETATION Programme and the VGT4AFRICA project. The European Commission jointly developed the VEGETATION Programme. The VGT4AFRICA project disseminates VEGETATION products in Africa through GEONETCast.

ARC-ISCW has an archive of VEGETATION data dating from 1998 to the present. Other products distributed through VGT4AFRICA and GEOSUCCESS include Net Primary Productivity, Normalized Difference Wetness Index and Dry Matter Productivity data.

Meteosat Second Generation (MSG)

The ARC-ISCW has an operational MSG receiving station. Data from April 2005 to the present have been archived. MSG produces data with a 15-minute temporal resolution for the entire African continent. Over South Africa the spatial resolution of the data is in the order of 3 km. The ARC-ISCW investigated the potential for the development of products for application in agriculture. NDVI, LST and cloud cover products were some of the initial products derived from the MSG SEVIRI data. Other products derived from MSG used weather station data, including air temperature, humidity and solar radiation.

Rainfall maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network, 270 automatic rainfall recording stations from the SAWS, satellite rainfall estimates from the Famine Early Warning System Network: **http://earlywarning.usgs.gov** and long-term average climate surfaces developed at the ARC-ISCW.

Solar Radiation and Evapotranspiration maps

- Combined inputs from 450 automatic weather stations from the ARC-ISCW weather station network.
- Data from the METEOSAT Second Generation (MSG) 3 satellite via GEONETCAST: **http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast/GEONETCast/index.html**.

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What does Umlindi mean?
UMLINDI is the Zulu word for "the watchman".